MONTANA DEPARTMENT OF FISH AND GAME
ECOLOGICAL SERVICES DIVISION

ANNUAL PROGRESS REPORT

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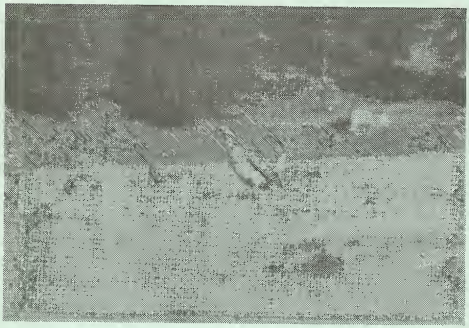
Project Number: MON 76-312

Project Title: In-situ uranium mining, Long Pines, Montana

Period Covered: September 1, 1977 through August 31, 1978



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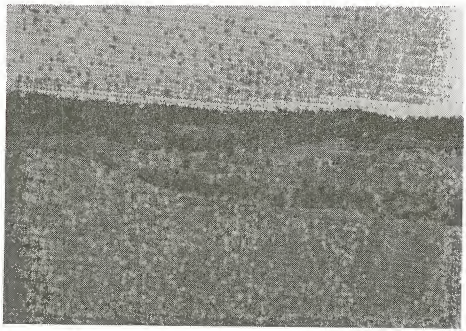
Date: December 29, 1978

TABLE OF CONTENTS

Page



LIST OF TABLES

LIST OF TABLES CONTINUED

LIST OF FIGURES

INTRODUCTION

A terrestrial wildlife inventory to gather baseline data was undertaken by the Montana Department of Fish and Game during September 1976 in the Long Pines, a portion of the Sioux District of the Custer National Forest, in light of potential development of uranium. Of primary concern was Mobil Oil Corporation's "Fox Hills Project" in the Long Pines and adjacent state and private lands (Stellingwerf 1975). Exploration work began during 1972 and was continued each year through summer 1977, while no exploratory work was conducted during 1978. Sioux District personnel (USFS) indicated that Mobil does not intend to develop uranium reserves in the Long Pines and may try to farm out its claims to a smaller company (Nordberg 1978).

Since the management plan for the Sioux District precluded surface mining (U.S. Forest Service, USDA 1976), partially due to depths of uranium-bearing strata, solution or "in-situ" mining is believed by many to be the most feasible means of recovering uranium. It is also considered to be a more environmentally compatible means of recovering uranium.

The terrestrial wildlife study was funded by the U.S. Fish and Wildlife Service (USFW) through the Office of Biological Services (OBS) for three years. This report summarizes field data gathered during the year ending August 31, 1978 with comparative data from the previous year (Dusek 1977). The purpose of the project was to fulfill the following objectives:

(1) To identify potential conflicts between in-situ mining in the Long Pines and vicinity and wildlife populations and develop criteria for eliminating, reducing, or compensating those conflicts;

(2) to furnish ecological data necessary to monitor the effects of in-situ mining on vegetation and wildlife populations;

(3) to utilize the Long Pines as a model demonstration site for researching the compatibility of wildlife habitat and in-situ mining;

(4) to develop revegetation techniques or innovations necessary to replace wildlife habitat disturbed by in-situ mining;

(5) to monitor secondary impacts from in-situ mining on wildlife populations and develop alternatives to reduce adverse impacts.

STUDY AREA

The study area (Figure 1) includes the portion of the Sioux District of the Custer National Forest known as the Long Pines, located in east-central Carter County in southeastern Montana. National forest lands, together with private inholdings encompass approximately 65,000 acres (102 square miles). The entire study area, which also includes private and state lands extending from one-two miles out from the periphery of the national forest, encompasses approximately 122,880 acres (192 sq. mi.).

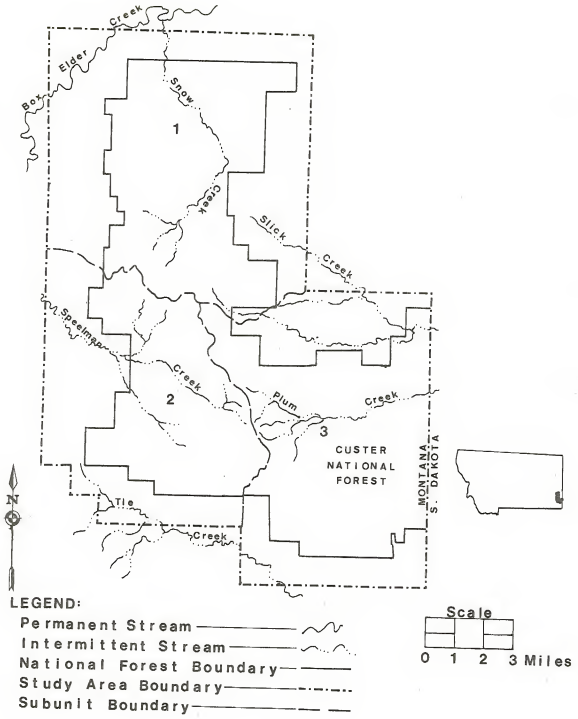


Figure 1. The Long Pines study area in Carter County, Montana

To facilitate gathering and interpreting some of the survey data, the study area was divided into three subunits (Figure 1), each corresponding to a major drainage within the study area: 1) Snow Creek subunit, 2) Speelman Creek subunit, and 3) Plum Creek subunit.

The Long Pines study area occurs in the Little Missouri River drainage. Upland portions occur as a series of ridges and mesas rising to approximately 1,200 feet above the surrounding plains. Drainages on the east side flow directly into the Little Missouri, while those on the west side drain into Box Elder Creek, the only permanent stream crossing the study area (Figure 1).

Climatological data for the report period (Table 1) were obtained from that recorded at Ekalaka, Montana and Camp Crook, South Dakota (U.S. Dept. Comm. 1977-78). Precipitation during the report period (Table 1) offered a contrast to that which fell during the 1976-77 report period (Dusek 1977). For example, Ekalaka, which lies northwest of the study area, received 22.82 inches of precipitation from September 1977 through August 1978, while receiving only 11.13 inches during the same period of 1976-77. Ekalaka averages 15.32 inches of precipitation per year of which approximately 59 percent normally falls from April through July. Camp Crook averages 13.67 inches of precipitation per year of which 73 percent normally falls from April through July. Portions of the Long Pines undoubtedly receive greater precipitation than do either of the two reporting stations due to elevational differences.

Average monthly temperatures for Ekalaka were near normal throughout the report period except from November 1977 through February 1978 when average monthly temperatures varied from 2.4°F to 10.1°F below normal (Table 1). This, coupled with 4.93 inches of precipitation during that period (2.99 inches above normal) for the same period resulted in snow cover that persisted through March 1978. Comparative temperature data were unavailable for Camp Crook, although average monthly temperatures at the two stations were similar.

SCOPE OF WORK

Effort during the report period was devoted exclusively to three phases of the study, which included a qualitative vegetational analysis, a wildlife ecology study and an evaluation of recreational use of the Long Pines. Other phases will receive attention as field work is completed.

Analysis of Vegetational Communities

Vegetational cover and species composition was sampled at 41 sites among ten vegetational communities in the Long Pines during the summers of 1977 and 1978. Twenty plots were sampled at each site using a method similar to that described by Daubenmire (1959). Frequency of low growing vegetation among plots and sites sampled appears in Tables 2 and 3.

Table 1. Climatological data for the period of September 1977 through August 1978 from two stations near the Long Pines study area.

	EKALAKA, MONTANA					CAMP CROOK, SOUTH DAKOTA			
	Temperature		Precipitation			Temperature		Precipitation	
Month	Avg.	Dep. from Normal	Total	Dep. from Normal	Month	Avg.	Dep. from Normal	Total	Dep. from Normal
September	57.7	.2	3.33	1.92	September	58.9	-	2.63	1.43
October	47.4	.4	1.85	1.12	October	47.6	-	2.37	1.73
November	29.0	-2.4	.83	.26	November	29.5	-	.94	.54
December	17.3	-5.6	1.35	.95	December	16.5	-	.75	.46
January	9.2	-8.3	.74	.18	January	6.6	-	.07	-.28
February	12.4	-10.1	2.01	1.60	February	11.7	-	1.04	.71
March	32.1	3.5	.06	-.57	March	--	-	--	-
April	43.5	.7	1.19	-.11	April	44.6	-	1.42	.11
May	54.3	.7	5.92	3.67	May	54.5	-	3.59	1.05
June	62.8	.9	2.26	-1.41	June	62.0	-	1.33	-1.86
July	68.8	-1.7	2.23	.34	July	68.6	-	3.76	2.05
August	68.6	- .9	1.05	-.45	August	68.8	-	.46	-1.07

Cover mapping was contracted to Ecological Consulting Services (ECON) of Helena, Montana. False-color infrared film (1:80,000 scale) was used to make the photo interpretation. The completed mylar map of vegetational communities was drawn at a scale of 1:24,000.

Vegetation communities in the Long Pines were grouped into two complexes regardless of successional relationships (Tables 2 and 3). One complex included communities with a conifer or hardwood overstory or an aspect dominated by deciduous shrubs (Table 2). This complex covered approximately 31 percent of the study area. The ponderosa pine/grassland and ponderosa pine/snowberry habitat types were similar to those described by Pfister et al. (1977). Potter and Green (1964) studied the ecology of ponderosa pine (*Pinus ponderosa*) along the Little Missouri drainage in southwestern North Dakota. The ponderosa pine/skunkbush habitat type was characterized by comparatively drier or savanna-like conditions with a comparatively more open canopy of pine than were the two types mentioned above. On some sites seedlings or saplings were the only evidence of pine. Martin (1973) reported that skunkbush sumac (*Rhus trilobata*) may be a component of communities dominated by pine or on seral communities capable of supporting pine. Major plants associated with skunkbush in the understory (Table 2) were similar to those reported by Brown (1971) in the Ashland Division of the Custer National Forest. The ponderosa pine/juniper habitat type in the Long Pines was also similar to a community described by Brown (1971).

The two remaining communities in the complex, hardwood and snowberry draws, were both riparian communities originating in the ponderosa pine dominated uplands extending to the lower stream channels in prairie grassland areas. This presented a unique situation in that there appeared to be a continual gradation of both overstory and understory plant species from upper to lower stream channels (Jorgensen 1977). Major tree species from upper to lower channels included quaking aspen (*Populus tremuloides*), fleshy hawthorne (*Crataegus succulenta*), green ash (*Fraxinus pennsylvanicus*), and plains cottonwood (*Populus deltoides*). Snowberry (*Symphoricarpos* spp.) seemed to be a component throughout the riparian continuum and is referred to as snowberry draws only where a deciduous tree overstory is lacking. For purposes of this report the four overstory phases are collectively referred to as hardwood draws.

The second complex (Table 3) included plant communities dominated by grasslands and/or sagebrush (*Artemisia* spp.). This complex, which also included agricultural areas (hay meadows and cropland), covered approximately 69 percent of the study area. All communities included in this complex, with the exception of grassland parks, occurred at lower elevations in the study area, primarily around the periphery of the ponderosa pine dominated uplands. These areas included rough breaks as well as gently rolling plains. Species composition in upland grassland parks and lowland rolling grasslands were nearly identical. The predominant grass or grasslike species occurring on both included western wheatgrass (*Agropyron smithii*), sedges (*Carex* spp.),

Table 2. Constancy and frequency of low-growing plants on five vegetation types with an overstory of ponderosa pine and/or deciduous trees and shrubs as determined from examination of 20 2x5 decimeter plots at each of 21 sites.

Taxa[a]	Ponderosa Pine-Grassland (4)[b]	Ponderosa Pine-Skunkbush (7)	Ponderosa Pine-Snowberry (5)	Hardwood Draw (3)	Snowberry Draw (2)
Grasses & Grasslike:					
Agropyron spp.	25/ 4[c]	29/ 6	80/ 17	33/ 7	50/ 20
Agropyron smithii	75/ 30	71/ 25	20/ 3	-	100/ 45
Agropyron spicatum	75/ 46	100/ 49	20/ 3	-	-
Andropogon scoparius	25/ 11	100/ 30	20/ 4	-	-
Aristida longiseta	-	29/ 3	20/ 5	-	-
Bouteloua curtipendula	-	57/ 18	-	-	-
Bouteloua gracilis	25/ 1	57/ 11	-	-	-
Bromus japonicus	-	43/ 16	-	-	-
Calamovilfa longifolia	25/ 10	100/ 30	-	-	-
Carex spp.	75/ 41	86/ 54	100/ 63	100/ 78	50/ 20
Elymus spp.	-	-	-	67/ 38	-
Koeleria cristata	50/ 24	-	40/ 12	-	50/ 5
Muhlenbergia cuspidata	-	57/ 12	-	-	-
Poa spp.	50/ 36	14/ 1	60/ 22	100/ 48	100/ 40
Stipa comata	100/ 14	100/ 30	60/ 7	-	-
Stipa spartea	-	-	20/ 15	-	-
Stipa viridula	50/ 7	29/ 6	100/ 57	-	50/ 22
Unidentified Grasses	25/ 6	14/ 1	60/ 7	33/ 13	50/ 30
TOTAL GRASSES	100/100	100/100	100/ 96	100/ 98	100/ 95
FORBS:					
Achillea millefolium	75/ 49	14/ 1	80/ 18	33/ 3	100/ 17
Anemone patens	50/ 17	-	20/ 6	-	-
Antennaria parvifolia	50/ 9	-	40/ 4	-	-
Antennaria rosea	-	-	-	-	50/ 2

Table 2. continued

Taxa	Ponderosa Pine-Grassland (4)	Ponderosa Pine-Skunkbush (7)	Ponderosa Pine-Snowberry (5)	Hardwood Draw (3)	Snowberry Draw (2)
FORBS continued					
Artemisia dracunculus	-	14/ 1	-	-	50/ 5
Artemisia frigida	-	43/ 5	-	-	50/ 2
Artemisia ludoviciana	50/ 29	57/ 8	80/ 19	33/ 3	100/ 47
Aster spp.	25/ 5	29/ 4	20/ 9	-	100/ 5
Cerastium arvense	25/ 6	14/ 1	40/ 2	33/ 23	-
Chrysopsis villosa	25/ 2	-	20/ 1	-	-
Comandra umbellata	25/ 4	29/ 5	20/ 2	-	-
Compositae	25/ 1	14/ 2	60/ 9	-	50/ 2
Convolvulus arvensis	-	-	-	33/ 23	-
Cruciferae	-	43/ 6	-	33/ 2	-
Echinaceae pallida	-	29/ 1	-	-	-
Erigeron canadensis	-	14/ 5	-	-	-
Erysimum inconspicuum	-	-	-	33/ 5	-
Galium spp.	25/ 1	-	20/ 3	-	-
Galium aparine	-	-	-	100/ 70	50/ 20
Galium boreale	-	-	80/ 22	100/ 15	50/ 22
Gaura coccinea	-	29/ 5	-	-	-
Geum triflorum	-	-	20/ 1	-	-
Glycyrrhiza lepidota	25/ 11	-	-	-	-
Lactuca serriola	-	43/ 5	20/ 1	-	-
Labiatae	-	-	-	33/ 12	50/ 20
Leguminosae	25/ 2	14/ 1	20/ 8	-	50/ 2
Lupinus argenteus	-	14/ 1	20/ 1	-	-
Mentha arvensis	-	-	20/ 2	33/ 7	-
Melilotus officinalis	-	29/ 5	-	33/ 3	-
Monarda fistulosa	-	-	-	33/ 22	50/ 45
Orthocarpus luteus	25/ 1	-	-	-	-
Osmorhiza spp.	-	-	-	33/ 5	-

Table 2. continued

Taxa	Ponderosa Pine-Grassland (4)	Ponderosa Pine-Skunkbush (7)	Ponderosa Pine Snowberry (5)	Hardwood Draw (3)	Snowberry Draw (2)
FORBS: continued					
Penstemon spp.	25/ 5	-	-	-	-
Phlox hoodii	25/ 2	43/ 7	20/ 1	-	-
Phlox longifolia	50/ 6	14/ 1	20/ 3	-	-
Plantago purshii	25/ 1	14/ 1	-	-	-
Potentilla spp.	-	-	-	33/ 8	-
Psoralea argophylla	50/ 6	43/ 12	-	-	-
Psoralea esculenta	25/ 4	100/ 13	20/ 3	-	-
Petalostemon purpureum	-	-	20/ 2	-	-
Smilicina stellata	-	-	40/ 5	100/ 25	-
Solidago spp.	-	14/ 1	-	-	-
Taraxacum officinale	75/ 5	14/ 1	40/ 4	67/ 30	50/ 2
Thermopsis rhombifolia	25/ 16	-	20/ 10	-	-
Thalictrum venulosum	-	-	40/ 4	67/ 20	-
Tragopogon dubius	75/ 9	43/ 3	60/ 6	33/ 3	50/ 10
Vicia americana	50/ 27	86/ 17	80/ 23	33/ 2	100/ 5
Viola spp.	-	-	20/ 1	33/ 13	-
Viola nuttallii	100/ 6	-	-	33/ 2	-
Unidentified forbs	100/ 24	100/ 41	80/ 25	67/ 45	100/ 92
TOTAL FORBS	100/ 91	100/ 74	100/ 79	100/ 98	100/ 92
TREES & SHRUBS:[d]					
Acer negundo	-	-	-	33/ 5	-
Berberis repens	-	-	60/ 44	67/ 30	-
Cretaegus succulenta	-	-	-	33/ 10	-
Fraxinus pennsylvanicus	-	-	-	67/ 7	-
Pinus ponderosa	50/ 6	-	100/ 14	-	-
Prunus virginiana	-	-	80/ 24	100/ 18	-

Table 2. continued

Taxa	Ponderosa Pine-Grassland (4)	Ponderosa Pine-Skunkbush (7)	Ponderosa Pine-Snowberry (5)	Hardwood Draw (3)	Snowberry Draw (2)
TREES & SHRUBS: continued					
Rhus trilobata	25/ 4	100/ 41	-	-	-
Rosa arkansana	25/ 4	-	80/ 8	33/ 7	100/ 22
Rubus idaeus	-	-	-	67/ 13	-
Symphoricarpos albus	75/ 25	29/ 7	100/ 56	67/ 38	100/ 90
Symphoricarpos occidentalis	-	-	80/ 13	67/ 23	100/ 82
TOTAL TREES & SHRUBS	100/ 34	100/ 46	100/ 94	100/ 82	100/100
Bare Ground	50/ 4	100/ 67	40/ 4	67/ 3	-
Rock	50/ 16	100/ 41	-	-	-
Club Moss	25/ 11	-	-	-	-
Lichens	25/ 4	14/ 1	-	-	-
Ground Litter	100/ 99	100/ 99	100/100	100/100	100/100
Standing Litter	100/ 20	100/ 54	100/ 45	100/ 25	100/ 87

a Includes those plants with an average frequency of five percent or more in at least one vegetation type in Tables 2 and 3.
b Number of sites analyzed within each vegetation type.
c Percent occurrence among sites/percent occurrence among plots.
d Tree species listed under this category include only seedlings in the understory.

Table 3. Constancy and frequency of low-growing plants on five vegetation types with a predominant cover of grass and/or sagebrush as determined from examination of 20 2x5 decimeter plots at each of 20 sites.

Taxa[a]	Grassland (4)[b]	Grassland Park (8)	Big Sagebrush-Grassland (4)	Silver Sagebrush-Grassland (2)	Sagebrush-Rabbitbrush Breaks (2)
GRASSES & GRASSLIKE:					
Agropyron spp.	75/ 21[c]	50/ 29	100/ 42	50/ 2	50/ 10
Agropyron smithii	100/ 77	100/ 85	75/ 55	100/ 85	50/ 10
Agropyron spicatum	25/ 1	-	-	-	50/ 15
Andropogon scoparius	50/ 6	12/ 7	-	-	-
Aristida longiseta	100/ 26	37/ 9	-	-	-
Bouteloua curtipendula	-	-	-	50/ 22	-
Bouteloua gracilis	100/ 42	87/ 31	75/ 31	50/ 27	50/ 2
Bromus japonicus	75/ 22	37/ 7	75/ 22	-	100/ 7
Carex spp.	100/ 84	100/ 74	50/ 9	50/ 50	50/ 2
Calamovilfa longifolia	-	12/ 2	-	-	-
Festuca octiflora	50/ 16	-	25/ 1	-	-
Koeleria cristata	100/ 67	100/ 53	100/ 41	100/ 47	50/ 5
Muhlenbergia cuspidata	25/ 7	-	-	-	-
Poa spp.	50/ 2	75/ 35	25/ 24	100/ 40	100/ 7
Poa secunda	75/ 36	-	75/ 32	-	-
Stipa comata	100/ 49	100/ 59	50/ 14	100/ 15	50/ 2
Stipa viridula	-	25/ 12	100/ 27	100/ 25	50/ 10
Unidentified grasses	25/ 2	25/ 1	-	-	-
TOTAL GRASSES	100/100	100/100	100/ 99	100/100	100/ 45
FORBS:					
Achillea millefolium	50/ 7	75/ 32	25/ 2	100/ 35	-
Antennaria rosea	50/ 9	75/ 12	-	50/ 2	-
Artemisia dracunculus	50/ 5	37/ 7	-	50/ 2	-

Table 3. Continued

Taxa	Grassland (4)	Grassland Park (8)	Big Sagebrush-Grassland (4)	Silver Sagebrush-Grassland (2)	Sagebrush-Rabbitbrush Breaks (2)
FORBS: continued					
Artemisia frigida	100/ 44	87/ 31	25/ 2	50/ 2	-
Artemisia ludoviciana	-	75/ 33	-	100/ 47	-
Aster spp.	25/ 6	75/ 32	-	50/ 32	-
Atriplex nuttallii	-	-	-	-	50/ 5
Cerastium arvense	-	37/ 7	-	50/ 2	-
Chrysopsis villosa	50/ 6	25/ 6	-	-	-
Compositae	25/ 1	12/ 11	-	50/ 5	50/ 2
Comandra umbellata	-	12/ 2	25/ 1	-	-
Cruciferae	50/ 2	-	25/ 1	-	-
Echinaceae pallida	75/ 19	62/ 6	-	-	-
Erigeron canadensis	25/ 9	12/ 1	-	-	-
Eriogonum spp.	25/ 4	-	25/ 5	-	50/ 27
Eurotia lanata	-	-	-	-	-
Galium spp.	25/ 9	12/ 1	-	-	-
Gaura coccinea	25/ 2	12/ 11	-	-	-
Geum triflorum	-	12/ 6	-	-	-
Grindelia squarrosa	-	-	75/ 7	-	50/ 5
Gutierrezia sarothrae	50/ 11	12/ 2	-	-	100/ 5
Lactuca serriola	-	12/ 6	50/ 7	100/ 12	100/ 5
Leguminosae	25/ 1	62/ 12	-	50/ 10	50/ 2
Lupinus argenteus	-	12/ 1	-	-	-
Lygodesmia juncea	50/ 16	37/ 2	25/ 12	-	-
Melilotus officinalis	25/ 1	-	75/ 7	-	50/ 10
Opuntia polycantha	-	-	25/ 1	50/ 2	-
Orthocarpus luteus	100/ 15	37/ 5	-	-	-
Penstemon spp.	-	12/ 2	-	-	-
Petalostemon purpureum	50/ 10	25/ 10	50/ 6	50/ 2	-
Phlox hoodii	75/ 16	12/ 2			50/ 5

Table 3. Continued

Taxa	Grassland (4)	Grassland Park (8)	Big Sagebrush-Grassland (4)	Silver Sagebrush-Grassland (2)	Sagebrush-Rabbitbrush Breaks (2)
FORBS: Continued					
Phlox longifolia	50/ 5	37/ 11	-	-	-
Plantago purshii	100/ 34	12/ 4	25/ 19	-	-
Psoralea argophylla	75/ 17	75/ 17	25/ 1	50/ 5	-
Psoralea esculenta	75/ 19	75/ 18	-	50/ 15	-
Ratibida columnifera	50/ 6	75/ 21	-	-	-
Salsola kali	-	-	-	-	50/ 5
Solidago spp.	50/ 7	50/ 6	-	50/ 2	-
Sphaeralcea coccinea	75/ 25	25/ 4	50/ 12	-	-
Taraxacum officinale	-	12/ 1	-	-	
Thermopsis rhombifolia	-	25/ 9	-	-	-
Tragopogon dubius	25/ 1	50/ 6	50/ 2	50/ 5	-
Vicia americana	-	-	25/ 2	50/ 10	-
Viola nuttallii	-	12/ 1	-	50/ 2	-
Unidentified Forbs	75/ 16	62/ 18	100/ 21	100/ 32	50/ 5
TOTAL FORBS	100/ 96	100/ 99	100/ 71	100/ 77	100/ 62
SHRUBS:					
Artemisia cana	-	-	25/ 1	100/ 37	50/ 7
Artemisia tridentata	-	-	100/ 74	-	50/ 5
Chrysothamnus viscidiflorus	-	-	-	-	100/ 40
Rosa arkansana	25/ 1	12/ 1	-	-	-
TOTAL SHRUBS	25/ 1	12/ 1	100/ 76	100/ 37	100/ 47
Bare ground	100/ 94	87/ 43	100/ 84	100/ 60	100/ 97
Rock	25/ 4	25/ 3	-	-	100/ 25
Club Moss	75/ 41	75/ 45	50/ 29	-	-
Lichens	50/ 26	12/ 7	75/ 24	-	-
Ground Litter	100/ 97	100/100	100/ 99	100/100	100/ 57
Standing Litter	100/ 29	100/ 34	100/ 47	100/ 35	100/ 22

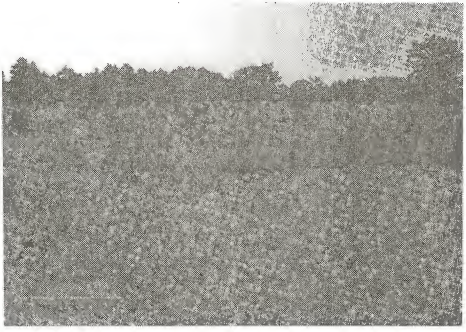
Table 3. Continued.

[a] Includes those plants with an average frequency of five percent or more in at least one vegetation type in both Tables 2 and 3.

[b] Number of sites sampled in each vegetation type.

[c] Percent occurrence among sites/percent occurrence among plots.

Junegrass (*Koeleria cristata*), and needle-and-thread (*Stipa comata*). Big sagebrush-grasslands are confined to areas of poorly drained clay soils on gentle slopes, drainage bottoms or breaks, while silver sagebrush-grasslands are almost exclusively confined to drainageways. Sagebrush-rabbitbrush breaks are confined primarily to badland sites as described by Brown (1971). Occasionally Rocky Mountain juniper (*Juniperus scopulorum*) is found on these sites.



Wildlife Ecology Study

White-tailed Deer

White-tailed deer (*Odocoileus virginiana*) inhabit the entire study area, with the exception of the extreme northeast corner. They are also the most abundant big game species in the area. An estimated minimum average density of 8 white-tailed deer per square mile occurred in the study area during early winter 1977-78. The method of determining this figure will be discussed later on. Actual density obviously varied throughout the study area with the greatest density occurring in the more heavily timbered portions, particularly the southern half.

Range Use

Site Selection

Seasonal use of habitat types, gradients and exposures by white-tailed deer during the report period were evaluated from 824 observations of individual animals (Tables 4, 5 and 6). Since this species selected timbered habitat, and was difficult to observe in dense stands of ponderosa pine from a fixed-wing aircraft, nearly all observations were obtained from ground surveys. Forty-eight percent of the observed annual habitat use occurred in stands of ponderosa pine. Gradients of 15o or less accounted for 77 percent of the total observations for the report period of which approximately 50 percent occurred on level ridgetops and in drainage bottoms. Seasonal changes in use of four classes of gradient were not readily apparent (Table 5).

In addition to data from routine ground surveys, 234 relocations among ten radio-equipped adult whitetails were used to evaluate use among habitat types (Table 4). This sample also included data from spring and summer 1977. Since only 52 percent of these relocations involved actually seeing the animal, a chance of error occasionally existed in determining the habitat type occupied when relocated animals were not actually observed. Bearing this in mind, and the fact that the number of individuals involved was quite small, data from radioed deer generally indicated that use of habitat types with an overstory of ponderosa pine, or of green ash, may have been underestimated by data from ground surveys.

Fall - During fall 53 percent of the observed use occurred in ponderosa pine habitat types of which the ponderosa pine/snowberry habitat type accounted for the bulk (Table 4). Significant use of agricultural areas and grassland parks was observed from ground surveys during fall 1977. The data in Table 4 perhaps do not reflect actual use of hardwood draws by white-tailed deer. During this period, especially during the hunting season, such draws appeared to serve as avenues of travel just prior to and following diurnal periods of feeding. Hardwood draws bisect vast areas of grassland and agricultural areas, providing secure cover for deer while traveling. This situation was particularly obvious in the Tie Creek drainage during fall 1977.

Winter - Coniferous habitat types accounted for their greatest seasonal use during winter 1977-78 with the largest proportion of this use occurring in the ponderosa pine/snowberry habitat type (Table 4). Use of hardwood draws during this winter occurred primarily in close proximity to stands of ponderosa pine. Winter 1977-78 was characterized by below normal temperatures and above normal precipitation during all three months (December-February). Snow depths exceeded two feet throughout the study area, except on wind exposed areas. Conditions were particularly severe during February. During severe storm conditions whitetails used the densest stands of pine including "doghair". Several

Table 4. Seasonal use of habitat types by white-tailed deer in the Long Pines study area as determined from routine ground surveys and aerial tracking of radio-equipped animals.

Habitat Type	Fall 1977 (358)	Winter 1977-78 (119)/(62)[a]	Spring 1978 (212)/(100)	Summer 1978 (135)/(72)
Ponderosa Pine/Grassland	15	16/32[b]	8/32	13/10
Ponderosa Pine/Skunkbush	1	3/10	-/ -	2/ -
Ponderosa Pine/Snowberry	37	43/55	16/22	38/35
Hardwood Draw	6	14/ -	3/20	7/26
Snowberry Draw	5	- / -	8/ -	2/ -
Cottonwood Stream Bottom*	-	- / -	-/ -	-/10
Grassland	7	7/ -	17/15	7/11
Grassland Park	11	12/ 3	17/ 2	9/ 3
Sagebrush/Grassland	1	3/ -	-/ -	-/ -
Agricultural	17	3/ -	31/ 3	23/ 6

[a] Sample size for a respective season-ground surveys/radioed animals - radio tracking data also included that gathered prior to September 1977 to provide meaningful sample size.

[b] Percent of seasonal observations - ground surveys/radioed animals.

* Includes the observations of one radioed adult female that moved from the study area to the Little Missouri River in South Dakota during summer 1978.

Table 5. Seasonal distribution of white-tailed deer among four classes of gradient during the report period.

Gradient	Fall 1977 (358)[a]	Winter 1977-78 (119)	Spring 1978 (212)	Summer 1978 (135)
0-15°	78[b]	73	78	81
16-30°	15	17	13	11
31-45°	6	9	7	7
46°+	tr[c]	1	2	1

[a] Sample size for a respective season.

[b] Percent of seasonal observations.

[c] tr - trace (a value less than .5 percent).

Table 6. Seasonal distribution of white-tailed deer among ridgetops, drainage bottoms and four classes of exposure during the report period.

Exposure	Fall 1977 (358)[a]	Winter 1977-78 (119)	Spring 1978 (212)	Summer 1978 (135)
Level Ridgetop	29[b]	21	8	22
Level Bottoms	29	29	50	27
North	4	9	3	15
East	18	15	13	16
South	8	20	18	9
West	11	5	8	11

[a] Sample size for a respective season.

[b] Percent of seasonal observations.

authors have observed use of areas with a comparatively dense overstory of conifers by white-tailed deer during severe winter conditions (Ozoga 1968, Wetzel et al. 1975 and Drolet 1976). The ponderosa pine/ snowberry habitat type in the Long Pines most likely offers the most uniform microclimate and serves to reduce loss of body heat. Although 50 percent of the deer observed were in relatively level areas, those occurring on some degree of gradient were largely observed on southerly and easterly exposures.

Spring- A major shift in habitat use by white-tailed deer was observed from winter to spring 1978. Snow cover began receding during March and agricultural areas and grasslands began greening up during early April. Sixty-five percent of the seasonal use, as determined from ground surveys occurred in such areas (Table 4). This was comparable to that observed during spring 1977 (Dusek 1977). Data from radioed deer indicated greater use of hardwood draws than did that from ground surveys. Bottomlands received their greatest use during this season (Table 6).

Summer - Summer 1978 was characterized by comparatively wetter climatological conditions, which resulted in a more abundant cover of herbaceous vegetation than the previous summer (Dusek 1977). However, the pattern of distribution of whitetails among the various vegetational communities, as determined from ground surveys, was not significantly different between the two years. During this season, whitetails increased their use of the ponderosa pine/snowberry habitat type from spring (Table 4). Use of nontimbered communities along major stream bottoms decreased from spring while use of ridgetops increased. Northerly exposures received their greatest use during summer (Table 6).

Home Range and Movements

From mid-December 1977 through early February 1978, 55 white-tailed deer were captured and individually marked to evaluate annual and seasonal home ranges, movements and dispersal. Capture was facilitated by use of an "Oregon" trap (Mackie 1972) at five locations and a single-gate Clover trap (Clover 1956) at four locations. The sample included 25 adults and 30 fawns.

Six animals, three females and three males, were fitted with collars containing radio transmitters. One consisted of two-inch polyvinyl chloride pipe (PVC) molded into a diamond shape with a 21-inch circumference. The other five were equipped with commercially built collars (Wildlife Materials, Inc., Carbondale, Ill.). The remaining 49 whitetails were fitted with individually recognizable collars (Dusek 1977). A numbered metal tag was affixed to the right ear of the 55 deer to provide location data in the event an animal was found dead or taken by a hunter with no other individually identifiable material present. A plastic livestock tag was

affixed to the left ear of most fawns with a painted symbol representing the capture site.

During the report period, 22 of the 49 collared whitetails were observed one or more times. One was relocated ten times. Five of 27 animals, collared during winter 1976-77, were also observed during the report period. One of these, a two-year-old male, was observed 15 times since it was captured as a fawn. Of the six radioed animals captured during winter 1977-78, two were left at the end of the report period. Of those radioed the previous winter, one was left and was monitored throughout the report period. Two hundred and seventy-three relocations of radio-equipped deer were placed on a computer file, from which such computations as home range size, geographic activity center, standard diameter, maximum, minimum and mean distances between successive relocations could be obtained between any two given dates.

As determined from 273 relocations of radio-equipped deer and 118 observations of collared animals, which also included observations obtained during the previous report period, white-tailed deer generally appeared to restrict their activity during winter to the portion of the study area composed of national forest (Figures 2 and 3). Movement from the forest to adjacent private lands during winter consisted almost exclusively of travel to and from nearby haystacks. Although activity throughout the year of some individual animals was confined exclusively within the national forest boundary, greatest dispersal of whitetails from the forest occurred during fall, spring and summer, which coincided with comparatively heavy use of nontimbered habitat types, particularly agricultural areas, grasslands and hardwood draws.

Centers of activity (Hayne 1949) were plotted by season for six radio-equipped adult deer, which included four females and two males (Figure 4). Four of these animals shifted their pattern of activity toward or beyond the forest boundary from winter 1977-78 to spring 1978. Most of this spring dispersal included movement off the national forest to feed and return to wooded areas within the national forest during mid-day. During summer 1978, one adult female remained on the floodplain of Tie Creek during the entire season not returning to the national forest during mid-day. Two other females moved off the forest to use grassland areas during diurnal feeding periods during early summer 1978. During late July both moved into the Little Missouri River floodplain in South Dakota and did not return to the forest the remainder of the season. One of these does had been radioed since February 1977 and did not make this seasonal shift during summer 1977. This pattern of dispersal from winter concentration areas during spring and summer, coupled with winter site selection, was similar to that observed by Harmoning (1976) in the Missouri Coteau of southcentral North Dakota.

The minimum home range (Mohr 1947) was used to evaluate seasonal movement patterns among and between individuals. Seasonal home ranges were computed

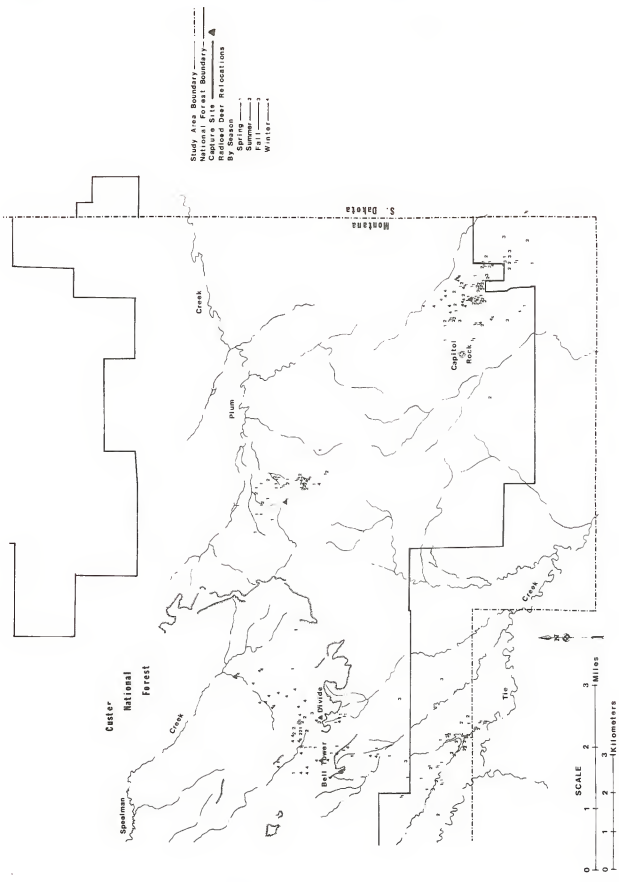


Figure 2. Distribution by season of relocations of ten radio-equipped white-tailed deer from February 1977 through August 1978.

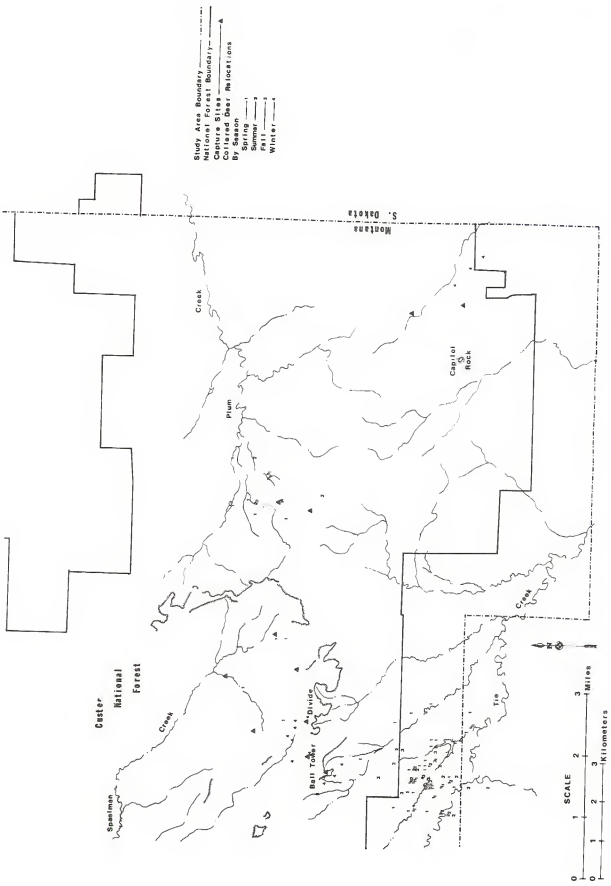


Figure 3. Distribution by season of sightings among 34 individually marked white-tailed deer from February 1977 through August 1978.

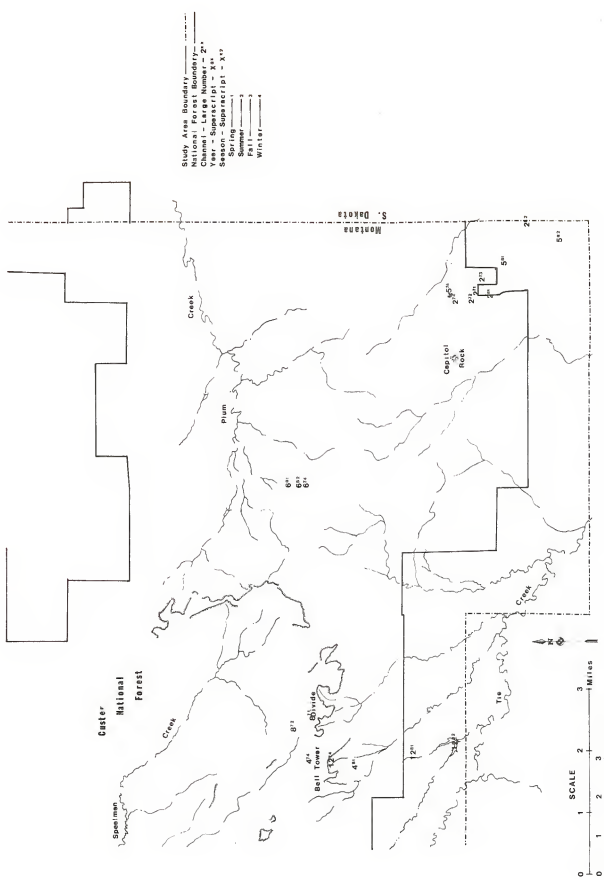


Figure 4. Distribution of geometric centers of activity by season for six radio equipped white-tailed deer monitored two or more consecutive seasons from February 1977 through August 1978.

for all ten radioed deer (Table 7). Home ranges were comparatively smaller and reflected less variability between individuals during winter than was observed during other seasons. Mean consecutive distances and maximum distances between successive relocations followed the same trend (Table 8). Differences in movement patterns between the two sexes were not readily apparent during winter, spring and summer. However, the sample of individuals may have been too small to establish a difference. No radioed males were available during fall 1977, a period when difference in movement patterns between the sexes would perhaps be most apparent. The sedentary nature of white-tailed deer in the Long Pines during winter reflected the "yarding behavior" similar to that of white-tailed deer in the Great Lakes region (Verme 1968 and Ozoga 1968). The severe weather conditions during winter 1977-78 perhaps influenced this sedentary behavior. Snow depths undoubtedly restricted movement since whitetails confined most movement to established deer trails. Deer may also have tended to move less as a means of conserving energy.

The following paragraphs summarize capture information, movement patterns, and status of ten adult whitetails equipped with radio transmitters since January 1977.

Deer 1752 was captured as an adult female in January 1977 on the Belltower Divide. She remained in that general area until mid-March when she began to use the Tie Creek floodplain. She was observed only on the floodplain from mid-April through May using agricultural areas and hardwood draws. She shed her radio collar in late May 1977. Her fawn from 1976, a male, had been marked in January 1977 also and was observed repeatedly in the Tie Creek drainage during the past 18 months.

Deer 1757 was captured as an adult female during January 1977 on the Belltower Divide and was monitored on channel 8 (Figure 4). She remained quite sedentary throughout spring and summer 1977 (tables 7 and 8) and occurred primarily in heavily timbered side drainages on the north side of the Belltower Divide along Speelman Creek. The transmitter failed during early August 1977. She was observed in the Tie Creek drainage on four occasions during fall 1977, in the Speelman drainage once in December, and last observed on the Belltower Divide during January 1978.

Deer 1762 was captured as an adult female southeast of Capital Rock during early February 1977 and was monitored on channel 2 (Figure 4). She remained in the vicinity of the trap site throughout the following 17 months. She was often located at the edge of the timber or in grasslands adjacent to the forest during early morning and evening hours during spring, summer and fall of 1977 but was generally found within the confines of timber cover on the national forest during mid-day. During winter 1977-78 she was observed off the forest once in a hay stack yard just adjacent to the forest. During late July 1978 she moved into the Little Missouri River drainage in South Dakota, a distance of approximately 4.5 miles southeast of the forest where she remained through the end of the report period.

Table 7. Total and seasonal home ranges of 10 adult white-tailed deer captured in the Long Pines and equipped with radio transmitters during the winters of 1976-77 and 1977-78.

Identification Number	Channel Number	Sex	Marked	No. of "Fixes"	Home Range[a] Total[b]	Fall* 1977	Winter* 1977-78	Spring* 1977	Spring* 1978	Summer* 1977	Summer* 1978
A-1752	6	F	1/17/77	12	1.3	-	-	1.3	-	-	-
A-1757	8	F	1/22/77	25	2.6	-	-	.4	-	tr[c]	-
A-1762	2	F	2/ 3/77	72	5.5	.3	.5	.6	1.5	.6	3.2
A-1764	10	F	2/27/77	15	.4	-	-	.4	-	-	-
A-1766	7	F	12/11/77	12	.4	-	.4	-	-	-	-
A-1769	5	F	12/12/77	39	7.8	-	.7	-	1.5	-	3.2
A-1772	4	M	12/13/77	26	2.2	-	.5	-	1.1	-	-
A-6805	12	F	1/11/78	31	1.9	-	.1	-	1.6	-	.1
A-6809	10	M	1/19/78	5	.6	-	.6	-	-	-	-
A-6813	6	M	1/21/78	31	1.6	-	tr	-	.5	-	1.2
Averages			Adult Females			.3[+]	.4	.7	1.5	.3	2.2
			Adult Males			-	.4	-	.8	-	1.2

[a] Home range size expressed in square miles.

[b] Total area used by an individual animal from the first to the last relocation regardless of season or year.

[c] tr - Seasonal home range was less than .1 square mile.

* Fall (Sept.-Nov.): Winter (Dec.-Feb.); Spring (March-May); and Summer (June-Aug.).

\+ Only one individual was represented in seasonal data.

Table 8. Seasonal movement patterns of 10 radio-equipped adult white-tailed deer in the Long Pines Study area.

Number	Sex	Mean Consecutive Distances Between Relocations: Fall 1977	Winter 1977-78	Spring 1977/1978	Summer 1977/1978	Maximum Distances Between Relocations: Fall 1977	Winter 1977-78	Spring 1977/1978	Summer 1977/1978
A-1752	F	-	-	1.3/ -	- / -	-	-	2.5/ -	- / -
A-1757	F	-	-	.4/ -	.1/ -	-	-	1.1/ -	.3/ -
A-1762	F	.7[a]	.4	.6/ .9	.6/ .7	1.6	.9	1.1/2.2	1.2/4.5
A-1764	F	-	-	.4/ -	- / -	-	-	.8/ -	- / -
A-1766	F	-	.5	- / -	- / -	-	1.2	- / -	- / -
A-1769	F	-	.6	- /1.3	- / .6	-	1.2	- /3.6	- /4.4
A-1772	M	-	.5	- / .8	- / -	-	1.3	- /1.5	- / -
A-6805	F	-	.3	- /1.0	- / .3	-	.4	- /2.2	- / .4
A-6809	M	-	.7	- / -	- / -	-	1.2	- / -	- / -
A-6813	M	-	.2	- / .5	- / .6	-	.3	- / .8	- /3.3
Adult Females		.7+	.4	.7/1.1	.3/ .5	1.6+	.9	1.4/2.7	.7/3.1
Adult Males		-	.5	- / .6	- / .6+	-	.9	- /1.1	- /3.3+

[a] Distances are expressed in miles.

\+ Only one individual was represented in seasonal data.

Deer 1764, an adult female, was captured near the McClary Ranger Station in Plum Creek during late February 1977. She used a comparatively small area during spring 1977 and her movements were much more restricted than those of other radioed deer during that period (Tables 7 and 8). Her spring home range was confined to a complex of ponderosa pine/snowberry, grassland parks and hardwood draws. She shed her collar during early June 1977.

Deer 1766, an adult female, was captured on the Belltower Divide in December 1977. She remained in the upper side drainages of Speelman Creek throughout the winter and succumbed to unknown causes during early March 1978.

Deer 1769, an adult female, was captured southeast of Capital Rock during December 1977. She was monitored on channel 5 and her pattern of movement and habitat use closely resembled that of 1762 during winter 1977-78 and spring and summer 1978 (Figure 4). However, during April she was observed along the Little Missouri River in South Dakota but was back in the Long Pines the next time she was located during the same month. She moved back to the Little Missouri during late July, a distance of approximately 4.5 miles and remained on the riverbottom hardwood/agricultural complex through the end of the report period. She was observed with a newborn fawn in that area.

Deer 1772, an adult male, was captured on the Belltower Divide during December 1977 and was monitored on channel 4 (Figure 4). He remained on the Belltower Divide, primarily in upper Maverick Gulch, through mid-March 1978. The area where he spent the winter was heavily timbered. His movements increased during late March and early April, but he continued to return to Maverick Gulch. He remained in the Tie Creek drainage, mostly in agricultural areas and hardwood draws, throughout late April and May. The transmitter failed during early June, but the animal was observed on the Tie Creek floodplain on four occasions during summer 1978.

Deer 1805, an adult female, was captured on the Belltower Divide during January 1978 and was monitored on channel 12 (Figure 4). She remained on the southside of the Belltower Divide in the Tie Creek drainage until the end of March when she moved down onto the Tie Creek floodplain where she remained through the summer. Her fawn from 1977 was also marked and was last seen on May 9, 1978. She was accompanied by two newborn fawns during summer 1978. This may have accounted for her sedentary behavior during summer. Her observed summer home range was .1 square miles and movements between successive relocations were considerably less than those of other radioed deer (Table 8). This animal died of unknown causes during late August 1978.

Deer 1809, an adult male, was captured in Speelman Creek during January 1978. He remained in dense timber and was rarely observed throughout the winter. During early spring 1978 he moved onto the Belltower Divide where he died, apparently from causes related to malnutrition.

Deer 6813, an adult male, was captured near the McClary Ranger Station during late January 1978 and was monitored on channel 6 (Figure 4). He remained exclusively in heavily timbered habitat through the end of March 1978. From April through August he used a complex of ponderosa pine, hardwood draws and grassland parks, being quite sedentary throughout that period (Tables 7 and 8) with the exception of one three-mile jaunt and subsequent return during July.

Food Habits

Semi-seasonal food habits of white-tailed deer were evaluated from analysis of 40 rumens taken from September 1977 through May 1978 (Table 9) using a method described by Wilkins (1957) and others. Twenty samples were obtained from hunter-killed whitetails during late fall, 12 from deer killed on collecting permits, seven from deer having died as a result of trapping, malnutrition and/or predation. The volume of bait material was deleted from the results from deer that died in traps. All samples were taken from the portion of the study area consisting of national forest. Agricultural crops occurring in the samples reflected deer moving from the forest to adjacent private lands to feed.

Fall

Browse, forbs, and grasses accounted for 85, 13, and 2 percent of the average volume, respectively, among three samples taken from September 1 through October 15, 1977. Snowberry was by far the most

Table 9. Semi-seasonal food habits of white-tailed deer in the Long Pines study area from September 1977 through May 1978 as determined from analysis of 40 rumens.

Taxa	Early Fall 1977 (3)[a]	Late Fall 1977 (20)	Early Winter 1977-78	Late Winter 1978	Early Spring 1978	Late Spring 1978
BROWSE						
Arctostaphylos ura-ursi	-	5/tr[c]	33/ 7	-	-	-
Artemisia cana	-	5/ 1	33/ 6	-	-	-
Berberis repens	100/ 4[b]	75/27	33/ 1	67/ 7	29/ 5	25/ 1
Cretaegus succulenta	-	30/ 4	33/tr	-	-	-
Juniperus communis	-	-	33/ 1	33/21	-	25/tr
Juniperus scopulorum	-	-	-	33/ 1	-	-
Pinus ponderosa	100/tr	60/ 1	100/45	100/61	100/48	50/tr
Prunus americana	67/10	5/tr	-	-	-	-
Prunus virginiana	67/10	30/ 4	100/19	33/ 6	71/18	50/ 5
Rhus trilobata	-	10/tr	-	-	14/tr	-
Ribes spp.	-	10/tr	-	-	-	-
Rosa arkansana	67/tr	20/tr	-	-	14/tr	-
Shepherdia argentea	-	5/ 1	-	-	-	-
Symphoricarpos spp.	100/61	85/14	-	33/tr	43/ 2	50/ 8
Unidentified Browse	33/tr	30/tr	100/13	33/tr	71/ 5	25/tr
TOTAL BROWSE	100/85	95/52	100/92	100/96	100/78	75/14
FORBS:						
Achillea millefolium	-	-	-	-	-	25/tr
Anemone patens	-	-	-	-	-	50/tr
Antennaria parvifolia	67/tr	20/tr	-	-	-	-
Artemisia ludoviciana	-	10/ 1	-	-	-	-
Aster spp.	33/tr	35/tr	-	-	-	-
Carthamus tinctorius	-	20/ 7	-	-	-	25/ 9
Chrysopsis villosa	-	10/ 2	-	-	-	-

Table 9. Continued.

Taxa	Early Fall 1977 (3)	Late Fall 1977 (20)	Early Winter 1977-78 (3)	Late Winter 1978 (3)	Early Spring 1978 (7)	Late Spring 1978 (3)
FORBS: continued						
Compositae	33/tr	5/tr	33/ 1	-	14/tr	25/tr
Geum triflorum	-	-	-	-	-	25/tr
Glycyrrhiza lepidota	33/ 3	20/ 1	-	-	-	-
Leguminosae	-	10/tr	-	-	14/tr	-
Linum rigidum	-	5/ 2	-	-	-	-
Medicago sativa	-	15/ 1	-	-	-	-
Melilotus officinalis	67/tr	5/tr	-	-	-	25/tr
Myriophyllum spp.	33/tr	30/tr	-	-	-	-
Polygonum spp.	-	10/tr	-	-	-	-
Taraxacum officinale	-	10/tr	-	-	-	25/tr
Tragopogon dubius	-	10/tr	-	-	-	25/tr
Yucca glauca	-	-	33/ 7	-	14/ 1	-
Unidentified Forbs	100/10	50/ 6	33/tr	33/ 1	43/ 4	100/14
TOTAL FORBS	100/13	90/20	100/ 8	33/ 1	43/ 5	100/23
GRASSES:						
Agropyron spp.	-	25/ 3	-	-	14/ 3	25/ 3
Andropogon scoparius	-	-	33/tr	-	-	-
Hordeum vulgare	-	30/12	-	-	-	-
Poa spp.	33/ 1	35/ 4	-	-	29/ 4	100/41
Unidentified Grasses	67/ 1	50/ 4	100/tr	67/ 1	71/ 1	100/18
TOTAL GRASSES	100/ 2	90/23	100/tr	67/ 1	71/ 8	
OTHER:						
Tree Moss	33/tr	35/ 3	33/tr	67/tr	43/ 7	25/tr
Club Moss	-	-	-	-	14/tr	-

Table 9. Continued

Taxa	Early Fall 1977 (3)	Late Fall 1977 (20)	Early Winter 1977-78 (3)	Late Winter 1978 (3)	Early Spring 1978 (7)	Late Spring 1978 (3)
OTHER: continued						
Lichens	-	-	-	-	14/tr	-
Mushrooms	-	40/ 1	-	-	-	-

[a] Sample size for a respective period.

[b] Frequency (percent occurrence among samples) /Average percent volume.

[c] tr - trace (a value less than .5 percent).

abundant item in the diet during early fall. Other browse, used in appreciable quantities, included wild plum (*Prunus americana*) and chokecherry (*P. virginiana*). No one forb species was prevalent in the diet during early fall (Table 9). The relative scarcity of forbs in the diet perhaps reflected the comparatively dry conditions during the preceding spring and summer.

The proportion of browse, forbs, and grasses used by whitetails during late fall 1977 approximated that during the same period of 1976 (Dusek 1977). The three respective classes averaged 52, 20, and 23 percent by volume among 20 samples. Oregon grape (*Berberis repens*) and snowberry, combined, accounted for 41 percent of the diet during that period. Agricultural crops, including both grasses and forbs, accounted for 20 percent of the diet during late fall. Included were safflower (*Carthamus tinctorius*), alfalfa (*Medicago sativa*) and barley (*Hordeum vulgare*).

Winter

During early winter 1977-78, browse and forbs accounted for 92 and 8 percent of the volume among three rumens (Table 9). During the same period of 1976-77 the combined use of Oregon grape and snowberry accounted for 65 percent of the diet (Dusek 1977). During 1977-78 snowberry occurred in none of the samples while Oregon grape occurred in one and averaged one percent by volume. These species were unavailable to deer due to deep snow which was not present throughout much of the same period during the previous year. Ponderosa pine accounted for 45 percent of the diet followed by chokecherry. Kamps (1969) and Martinka (1970) reported increased use of conifers by white-tailed deer when deep snow made low-growing deciduous shrubs unavailable. Among forbs, no one species occurred in more than one sample. Grasses occurred in all samples but accounted for an insignificant portion of the early winter diet.

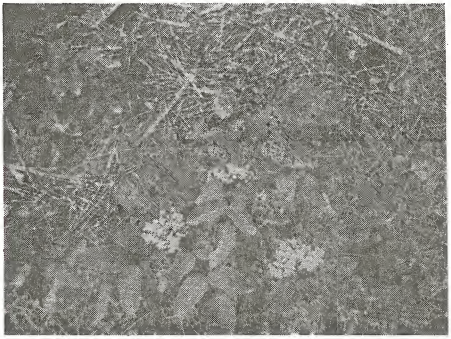
Browse increased to its highest level in the diet during late winter averaging 96 percent by volume among three samples gathered during the period. Deer increased their use of ponderosa pine from early winter (Table 9) while that on chokecherry decreased, perhaps due to exhaustion of available annual leader growth. Other browse occurring in the rumens during the period included common juniper (*Juniperus communis*), and Oregon grape.

Spring

Deep snow conditions persisted through March 1978, although some of the steep south exposures began to bare off about mid-March. As a consequence, snow cover continued to influence white-tailed deer food habits through the early spring period, particularly since it may have delayed spring greenup in the uplands. Browse accounted for 78 percent of the diet during early spring, a substantial decline from late winter.

Although its use decreased from late winter, ponderosa pine remained the most abundant item in the diet during early spring and occurred in all samples obtained during the period (Table 9). Deer increased their use of chokecherry from late winter. However, much of the chokecherry occurring in the rumens consisted of woody stems, some of which the diameter exceeded .25 inches. It was assumed that such portions of the stem of deciduous browse have a lower nutritional value for deer than distal portions and buds based on the relative difference in crude protein levels (Bailey 1967). Other browse occurring among rumens in measurable quantities during the period included Oregon grape and snowberry. Grasses accounted for eight percent of the diet during early spring which was predominantly bluegrasses (*Poa* spp.) and wheatgrasses (*Agropyron* spp.). Tree moss occurred in the rumens in appreciable quantities during the period.

Greenup brought about a major change in the relative use among the three forage classes by whitetails in the study area during late spring. Browse ebbed to its lowest use, while forbs and grasses received their greatest use (Table 9). They accounted for 14, 23, and 62 percent of the average volume among seven samples taken during the period, respectively. Among grasses, bluegrasses accounted for the bulk and were also the most abundant item in the rumens during late spring. Golden aster (*Chrysopsis villosa*) received the greatest use among forbs, while snowberry and chokecherry received nearly all of the use among browse.



Population Characteristics

During the report period 741 white-tailed deer were classified as to age (adult, yearling male, and fawn), sex (adults 1½+) and the type

of group they were associated with. Sex and/or age composition was also determined for samples of deer killed by hunters, deer trapped during winter 1977-78, among carcasses found on the study area during late winter and spring 1978, and among deer taken on a collecting permit throughout the report period.

Group Behavior

During the report period 345 groups of white-tailed deer were observed. Each was placed in one of ten categories based on sex and age composition (Table 10). Average group sizes by season, regardless of composition, were 2.4, 2.2, 3.2, and 1.8 during fall, winter, spring, and summer, respectively. The larger average group size observed during spring was influenced by comparatively large groups of deer observed on nontimbered sites, particularly meadows and agricultural areas along drainage bottoms that greened up earlier than other sites.

Except during summer, the type of group most commonly observed was a single adult female accompanied by fawn(s) (Table 10). The proportion of groups containing more than one adult female accompanied by fawns increased from fall to winter. Adult males were rarely observed with does or doe/fawn groups. Exceptions included the breeding season during November and in agricultural areas when deer concentrated in such areas. Solitary adult females were commonly observed during summer months, a pattern most likely related to fawning. Others have observed similar group behavior among white-tailed deer (Hawkins and Klimstra 1970 and Hirth 1977).

Population Numbers

An attempt was made to determine the size of the white-tailed deer population in the Long Pines study area during early winter 1977-78 (December 1-January 15). Since distribution of whitetails was concentrated in heavily timbered areas on the national forest it was not considered practical to determine population size by direct count from aerial surveys. Methods using the ratio of marked to unmarked animals could not be used since it was not known at any given time how many marked deer occurred in the study area due to mortality and loss of collars, and the entire study area was not equally trapped. An estimate was made by determining a ratio of white-tailed to mule deer in the study area from ground observations only. Vehicle routes were chosen to give the observer an equal opportunity to observe both species of deer. An estimate of the mule deer population was made by direct count during late December 1977 and early January 1978. A ratio of white-tailed to mule deer was arrived at by averaging the respective ratios obtained during spring, summer, and fall 1977. The estimated number of white-tailed deer was undoubtedly low since it was inconceivable that all mule deer in the study area were observed during the early winter aerial survey, and due to differences in habitat selection between the species, the estimated number of whitetails to mule deer may also have been somewhat low. Data from ground surveys during winter were

Table 10. Group characteristics of white-tailed deer in the Long Pines study area by season during the report period.

Group Class	Fall 1977 (150/358)[a]	Winter 1977-78 (54/119)	Spring 1978 (66/212)	Summer 1978 (75/135)
Unclassified	- / -	7/13	44/66	-/ -
Solitary Adult Male	19/ 8[c]	7/ 3	3/ 1	12/ 7
Solitary Adult Female	9/ 4	11/ 5	6/ 2	37/21
Adult Male Group	3/ 3	4/ 4	-/ -	4/ 5
Adult Female Group	5/ 4	2/ 2	3/ 2	5/ 7
Single Ad. Fem. W/Fawns(s)	41/43	22/25	9/ 6	19/26
Ad. Fem. Group W/Fawn(s)	11/19	18/28	- -	1/ 4
Mixed [b]	7/15	4/ 6	1/10	3/15
Fawn(s)	6/ 4	17/ 9	6/ 2	-/ -
Unclassified Adults	1/ 1	7/ 4	27/11	19/15

[a] Number of groups observed/number of deer observed.

[b] Included groups of adult males and females whether or not accompanied by fawns

[c] Percent of total groups/percent of total animals observed during a respective period.

not used since deep snow restricted travel on the national forest, in particular, decreasing the opportunity to observe white-tailed deer.

An estimated minimum population of 1,511 white-tailed deer occurred on the study area during early winter 1977-78 as determined from a population of 458 mule deer and a ratio of 3.3 whitetails per mule deer. Thus, an estimated minimum density of whitetails throughout the entire study area during early winter was 8 deer per square mile. Since most of the white-tailed deer occurred on the national forest (approximately 100 square miles) a more realistic minimum density in that portion of the study area was 15 deer per square mile. Habitat with a conifer overstory occurred over 28 percent of the study area. Since these habitat types were highly selected by white-tailed deer during winter, densities in some areas may have approached or even exceeded 28 deer per square mile.

Population Structure and Postnatal Production

Herd composition and annual production were evaluated from observed fawn:doe, fawn:adult, and buck:doe ratios (Table 11) obtained primarily from routine ground surveys. Due to differential observability between sex and age classes (Downing et al. 1977), such ratios cannot always be taken at face value. A comparison of summer and fall fawn:doe ratios suggested that newborn fawns were less observable during summer with perhaps the most accurate ratio observed during fall (Table 11). As a result of differential observability between adult males and females fawn:adult ratios were subject to some error but should still serve as an indicator of population trends between years. Buck:doe ratios varied considerably between summer and fall 1977 (55-34:100). It was unlikely that hunter harvest influenced this difference since nearly two-thirds of fall observations were made prior to the deer hunting season. A sample of 30 adults ($1\frac{1}{2}$+) was trapped during winter 1977-78 following the hunting season. This sample also included those that died incidental to trapping. A buck:doe ratio calculated from that sample was 43:100 and perhaps more accurately reflected the proportion of adult males in the population than did data from ground surveys, assuming there was no differential vulnerability to trapping among adult males and females.

An attempt was made to follow dynamics, or changes in composition by sex and relative abundance, of the 1977 year class (fawns born during June and July 1977). A prenatal fawn:doe ratio among does 2.5 years and older was 200:100 during late winter and spring 1977 (Dusek 1977) suggesting excellent prenatal production among those age classes. However, 12 of 14 fetuses, from which sex was determined, were males (86 percent). Verme (1965) suggested that females on a restricted diet produced a preponderance of male fawns. A postnatal fawn:doe ratio of 99:100 during fall 1977 indicated that the prenatal ratio was perhaps diluted by good recruitment of yearlings into the adult female segment of the population and/or some postpartum mortality occurred among fawns during summer 1977. A fawn:adult ratio of 65:100 during spring 1977 (Table 11) suggested that yearlings had been recruited into the adult population in substantial numbers during summer 1977.

Table 11. Population structure of white-tailed deer in the Long Pines study area.

Season	Female	Yearling Male	Adult Male	Unclassified	Fawns	Total	Fawns: 100 Does	Fawns: 100 Adults	Bucks: 100 Does
Fall:									
1976	36	5	8	-	32	81	89	65	36
1977	152	29	22	5	150	358	99	72	34
Winter:									
1976-77	63	4	8	25	80	180	-	80	-
1977-78	39	7	7	19	47	119	-	65	-
Spring:									
1977	17	-	-	189	135	341	-	65	-
1978	3	-	-	87	41	131	-	46	-
Summer:									
1977	104	21	36	2	47	210	45	29	55
1978	59	3	28	19	24	133	41	22	53

During winter 1977-78 the fawn:adult ratio was down slightly from that observed during fall 1977 (Table 11). A fawn:doe ratio was not determined from that period since adult males began shedding antlers during mid-December. The lower fawn:adult ratio during winter (65:100) was perhaps influenced in part by fawn mortality or possibly a greater observability of adult males than existed during fall. Assuming that one sex of fawns was not more vulnerable to trapping than the other, male fawns outnumbered females 158:100 (61 percent males) based on a sample of 31 fawns trapped during winter 1977-78. Fawns were more vulnerable to trapping than adults, as determined from a fawn:adult ratio of 103:100 in the sample of deer trapped.

Dead deer on the study area first become apparent during late February 1978 following a severe winter storm. Thirty-six dead whitetails were examined through mid-May 1978 as compared to 11 during the same period of 1977. For some carcasses examined during late spring, the metatarsal glands were the only obvious evidence of species (Kellogg 1956). Visual examination of femur marrow indicated that marrow fat had been completely mobilized in 27 (75 percent) of the 36 deer suggesting death was largely influenced by malnutrition. Fawns, yearlings, and adults accounted for 58, 3, and 33 percent of the total sample, respectively. Sex was determined for dead fawns by presence or absence of a pedicel. A male:female ratio among fawns in this sample was 320:100 suggesting that male fawns died at a rate of twice their relative abundance in the fawn segment when compared with the sample of deer trapped. In other words male fawns compared to females in the early winter population at a rate of 1.6:1 but died at a rate of 3.2:1.

During spring 1978 the fawn:adult ratio dropped to 46:100 which was well below that observed during the same period of the previous year as well as during winter 1977-78 (Table 11). The observed ratio was perhaps estimated high since it was obtained during a period when deer were still dying. Recruitment of the 1977 year class into the adult population as yearlings during early summer 1978 was obviously lower than for the 1976 year class during summer 1977. Observed yearling buck:adult doe ($1\frac{1}{2}$+) ratios were 20:100 and 5:100 during the summers of 1977 and 1978, respectively. Due to higher mortality of male fawns during winter and spring 1978, the relative proportion of the two sexes in the 1977 year class may have been nearly equal, or even heavier in females, during late spring and early summer 1978, depending on the proportion of that year class lost during the previous winter.

During late August several dead adult white-tailed deer were observed in the Tie Creek drainage. One of these was a radioed doe. Epizootic hemmorrhagic disease, a viral infection, was suspected to have caused the deaths but has not yet been confirmed.

Prenatal Production

Reproductive tracts were examined from 14 female white-tailed deer, either taken on a collecting permit or having died, from December 1977

through May 1978. The age of each animal was determined by tooth replacement or wear on the mandibular dentition (Severinghaus 1949). Included in the sample were one fawn, two yearlings, seven from 2.5 to 4.5 years, and four from 5.5 to 8.5 years. Those 3.5 years old (1974 year class) appeared to be the strongest age class among does 2.5 years and older. All females 2.5 years and older were pregnant as was one of the two yearlings, while the fawn was not pregnant. Of 10 adult females ($2\frac{1}{2}$+), from which fetuses were identified, six carried twins and four carried singles, representing a prenatal fawn:doe ratio of 160:100 among those age classes. This compared with a ratio, among similar age classes, of 200:100 during the previous year (Dusek 1977).

Ovaries of each were grossly examined by a technique described by Cheatum (1949) to determine ovulation rates. In all cases where fetuses were identifiable, the number of corpora lutea of pregnancy equalled the number of fetuses present. Ovulation rates of 1.6 and .5 were observed for adult and yearling females, respectively. However, in one 8.5 year old doe collected during mid-December 1977, three corpora lutea were observed, but fetuses were not yet identifiable. An ovulation rate of 1.86 was observed among adult does during late winter and spring 1977 (Dusek 1977). The lower ovulation rate for adult females observed during 1978, as compared to 1977, may have resulted from a lack of preferred herbaceous forage during summer and early fall 1977 as influenced by below normal precipitation during the spring and summer period. Julander (1961) reported a direct relationship between quality of summer range and productivity of mule deer in terms of ovulation rates, and pre- and postnatal fawn:doe ratios. From experimentation with white-tailed deer, Verme (1969) suggested that nutrition, just prior to breeding, greatly influenced production, particularly among yearlings. A preponderance of male fetuses in the sample also suggested a nutritional problem (Verme 1965). Of 14 fetuses from which sex was determined, nine (64 percent) were males. As discussed previously this phenomenon was also observed during 1977. Verme (1969) believed this to be a natural phenomenon when coupled with limited production, contributing to self regulation of a population directed towards depressing the herd's annual increment when range carrying capacity is seriously deteriorating.

Forehead-rump measurements were taken from 16 fetuses from 10 does. Breeding dates for each doe was determined by use of an embryonic growth curve (Cheatum and Morton 1946). The approximate date of conception was determined from counting back from the age of the fetus in days. Eighty percent of that sample (8) were bred from November 18 through December 3, 1977. Assuming an average gestation period of 201 days for white-tailed deer (Severinghaus and Cheatum 1956), the peak of fawning perhaps occurred between June 12 and 29, 1978.

Weights and Physical Condition

During the report period six white-tailed deer were weighed prior to dressing and again after viscera were removed. A dressing index,

dressed weight expressed as a percentage of the whole weight, was calculated for each. Whole weights of three adult females ($2\frac{1}{2}$+) taken during fall, winter and spring were 120, 130, and 115 pounds, respectively. Whole weights of two adult males taken during winter and spring were 135 and 115 pounds, respectively. One yearling male, taken during September 1977 weighed 98 pounds prior to dressing. Dressing indices varied from 65 to 70 percent with differences not apparent between seasons. Factors that may somewhat influence this ratio include physical condition, blood loss, and amount of material in the paunch (Quimby and Johnson 1951). Dressed weights of the six animals were less than statewide averages by age class reported by Mackie (1964) as determined from check stations throughout Montana during the hunting seasons of 1948-63. Dressed weights of whitetails in the Long Pines averaged 27, 31, and 43 percent less than statewide hunting season averages during fall, winter, and spring, respectively. An increase in departure from statewide averages during winter 1977-78 and spring 1978 indicated a loss of weight among deer in various sex and age classes throughout that period.

A kidney fat index was calculated for each of 28 white-tailed deer during the report period using a method described by Allen (1968). The index expresses the fat around the kidney as a percent of the weight of the kidney. Indices from 19 deer examined during the previous report period were used to make comparisons between seasons, years, and between sex and age classes (Figure 5 and Table 12). Ransom (1965) reported kidney fat indices to be a good indicator of physical condition when at or above 30 percent, while femur marrow is a better indicator when kidney fat falls below that level.

During the report period, average kidney fat indices, regardless of sex and age class, increased most sharply from early to late fall (Figure 5) and indicated that whitetails reached their peak condition just prior to the breeding season. The best distribution of data between sex and age classes was obtained during fall (Table 12) when deer killed by hunters accounted for 11 of 13 samples. Indices during fall were highly variable between individuals. They varied from 17 to 307 percent with both extremes occurring among adult females taken during the hunting season. During fall adult males accounted for the highest average indices among the various sex and age classes followed by yearling males, and adult females, respectively (Table 12). Kidney fat reserves declined sharply from late fall 1977 to early winter and declined further from late winter to early spring (Figure 5). The second sharp decline occurred approximately six weeks earlier during 1978 than that observed during 1977 and was perhaps influenced by extremely cold air temperatures from December 1977 through February 1978 (Table 1) coupled with a restricted diet resulting from an extended period of deep snow conditions not experienced during winter 1976-77. Adult females accounted for most of the samples during winter and spring and perhaps most accurately reflect seasonal trends among all sex and age classes (Table 12).

Table 12. Seasonal kidney fat indices of white-tailed deer by sex and age class from December 1976 through May 1978.

Sex and Age Class	Winter 1976-77/1977-78	Spring 1977 / 1978	Summer 1977	Fall 1977
Adult Female[a]	52[b](5)/ 62 (5)[c]	49 (5) / 11 (6)	26 (3)	122 (3)
Adult Male	- / 11 (1)	- / 11 (2)	26 (2)	216 (2)
Yearling Female	- / -	- / 8 (2)	22 (1)	111 (1)
Yearling Male	43 (1)/ -	- / -	-	171 (4)
Fawn Female	91 (1)/ -	- / 9 (1)	-	56 (2)
Fawn Male	- / -	9 (1) / -	-	117 (1)

[a] Adults include all animals two years and older.

[b] Average kidney fat index (kidney fat expressed as a percentage of the kidney by weight).

[c] Sample size for a respective season and year.

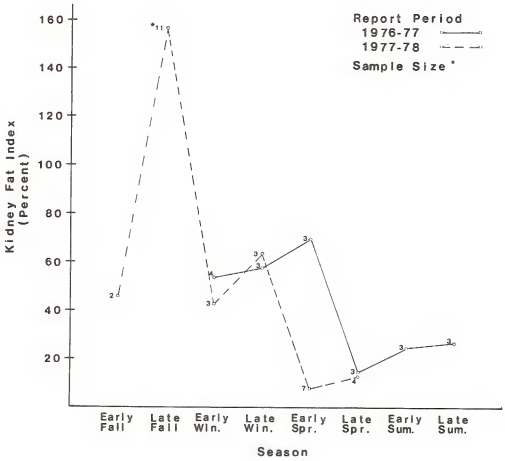


Figure 5. Semi-seasonal trends in physical condition of white-tailed deer as determined from kidney fat indices regardless of sex and age class.

Harvest Statistics

Species, age, and sex composition of deer harvested during the 1977 hunting season were determined by two methods. Questionnaires were distributed among 60 parties hunting on the national forest from the opening of the turkey season on September 24 through the end of the deer season on November 20. Twenty-one parties responded of which 17 hunted deer. The 17 parties included 54 hunters and reported killing 42 deer of which 32 (76 percent) were whitetails. Twenty-one (66 percent) of the whitetails in this sample were males which also included fawns.

Thirty-one hunter-killed white-tailed deer were aged in the field. Seventy-five percent of this sample were males, regardless of age class. However, 65 percent of the total sample were antlered males. Yearling males made up 26 percent of the total sample. This compared to 24 percent during fall 1976. Mundinger (1977) suggested a direct relationship between the proportion of yearlings in the population (including females) and annual harvest of white-tailed deer in northwestern Montana.

From the questionnaire, an estimated 92 white-tailed deer were harvested in the Long Pines during the 1977 hunting season. This compared to an estimated harvest of 59 whitetails from questionnaires distributed during the hunting season of 1976. These estimates were undoubtedly low since all hunting parties were not contacted during either year, but the data may have reflected trends in yearly harvest. The observed fawn:adult ratio of 65:100 observed during spring 1977 (Table 11) suggested substantial recruitment during summer 1977. Such data were unavailable for 1976. However, observed yearling buck:adult female (1½+) ratios during fall were 14:100 and 19:100 during 1976 and 1977, respectively, suggesting slightly higher recruitment during 1977. Fawns accounted for 10 and 20 percent of the harvest during 1976 and 1977, respectively. Good recruitment during 1977 coupled with comparatively high production during the same year may have accounted for the higher level of harvest of whitetails during 1977 as compared to 1976. As determined from the Department's statewide post-season questionnaire survey (unpublished data) white-tailed deer harvest in Region 7 declined from 1976 to 1977 (4,653 to 4,098) but increased between those hunting seasons in hunting district 781 which includes the study area (334 to 360).

It was unlikely that hunting contributed significantly to turnover in the white-tailed deer population in the Long Pines during the report period. None of the 31 deer marked during winter 1976-77 were reported killed by hunters during fall 1977, although marked animals were well represented in other forms of mortality including winter mortality, deer/automobile encounters and disease.

Mule Deer

Several researchers have gathered baseline data on mule deer (*Odocoileus hemionus*) in ponderosa pine upland/prairie complexes in southeastern Montana in light of potential coal and energy development (Biggins 1976, Knapp 1977 and Martin 1977). In the Long Pines study area this species occurred primarily near fringes of heavily timbered uplands or in grassland areas interspersed with rough breaks. Distribution of mule deer in the study area during winter is shown in Figure 6. Mule deer density averaged slightly more than two deer per square mile throughout the entire study area during early winter 1977-78.

Effort devoted to mule deer during the report period consisted largely of gathering range use and population data in a manner similar to that for white-tailed deer. However, aerial surveys were relied on more heavily, since the portion of the study area occupied by mule deer could

be surveyed from a fixed-wing aircraft. A collecting permit was obtained during May 1977 to facilitate gathering more intensive food habit and physical condition data.

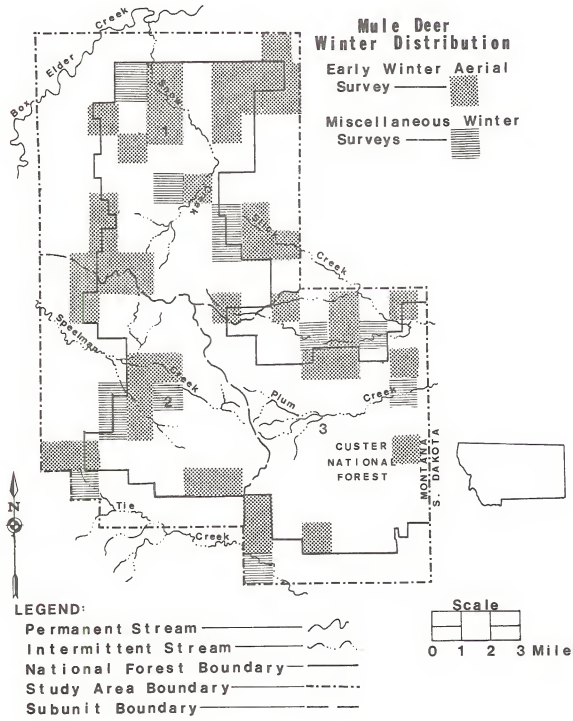


Figure 6. Distribution of mule deer in the study area during winter 1977-78 as determined from an early winter aerial census supplemented by miscellaneous ground and aerial surveys.

Range Use

Site Selection

Seasonal use of habitat types, gradients and exposures by mule deer during the report period was evaluated from 1,336 observations of individual animals (Tables 13, 14, 15, and 16). Seventy-three percent of the total observations were from aerial surveys. A cursory aerial survey was made in each of the subunits once each six weeks. An intensive aerial survey was conducted in the three subunits during early winter 1977-78 (Table 14). Since 31 percent of the observed annual habitat use by mule deer occurred in ponderosa pine habitat, mule deer obviously did not select timbered habitat to the extent that whitetails did.

Fall: During fall 1977 a wide variety of habitat received use by mule deer, although 59 percent of the observations occurred in the grassland, hardwood draw and ponderosa pine/grassland habitat types (Table 13). Agricultural areas received their greatest use by mule deer during fall as did snowberry draws. Sagebrush-rabbitbrush breaks accounted for seven percent of the season observations, but this type occurred over only three percent of the study area suggesting that mule deer may have selected this type over others. Other types receiving use during fall exceeding their representation on the study area included hardwood draws and agricultural areas. Gradients of 15o or less accounted for 70 percent of seasonal observations, most of which occurred in drainage bottoms (Tables 15 and 16).

Winter: During winter 1977-78 mule deer increased their use of timbered habitat types, all of which was observed in the ponderosa pine/grassland and p. pine/skunkbush habitat types (Table 13). The two types accounted for 45 percent of seasonal observations. The grassland habitat type received its greatest use by mule deer during winter and accounted for 31 percent of seasonal observations. The sagebrush/grassland habitat type also received its greatest use during winter. During winter slopes greater than 15^{o} accounted for 55 percent of seasonal observations as opposed to 30 percent during fall (Table 15). South and west exposures accounted for 47 percent of winter observations (Table 16). Those exposures were exposed to direct sunlight and/or wind and retained less snow cover than other exposures or relatively level terrain.

The early winter aerial survey indicated that selection of habitat types by mule deer differed between the three subunits (Table 14). This appeared largely due to distribution of the various habitat types within the study area. The ponderosa pine/skunkbush habitat type received most of its use in the north and southwest portions of the study area (Subunits 1 and 2) while grasslands received their use in the north and southeast portions (Subunits 1 and 3). Horizontal juniper (*Juniperus horizontalis*) occurred primarily in grasslands along the east side of the study area.

Table 13. Seasonal use of habitat types by mule deer in the Long Pines study area as determined from routine ground and aerial surveys during the report period.

Habitat Type	Fall 1977 (295)[a]	Winter 1977-78 (721)	Spring 1978 (197)	Summer 1978 (123)
Ponderosa Pine/Grassland	17[b]	28	22	20
Ponderosa Pine/Skunkbush	3	17	5	1
Ponderosa Pine/Snowberry	3	-	1	8
Hardwood Draw	18	2	10	15
Snowberry Draw	8	-	7	1
Grassland	24	31	27	29
Grassland Park	7	-	14	11
Sagebrush/Grassland	1	16	3	9
Sagebrush-Rabbitbrush Breaks	7	5	9	1
Agricultural	13	2	2	6

[a] Sample size for a respective season.

[b] Percent of seasonal observations.

Table 14. Habitat use by mule deer in three subunits in the Long Pines study area during early winter (Dec. 1 - Jan. 15) as determined from an intensive aerial survey.

Habitat Type	Subunit 1 (160)[a]	Subunit 2 (146)	Subunit 3 (152)	Total (458)
Ponderosa Pine/Grassland	31[b]	26	31	29
Ponderosa Pine/Skunkbush	25	21	1	16
Ponderosa Pine/Snowberry	-	-	-	-
Hardwood Draw	-	5	3	3
Snowberry Draw	-	-	-	-
Grassland	42	-	64	36
Grassland Park	-	-	-	-
Sagebrush/Grassland	1	25	-	8
Sagebrush/Rabbitbrush Breaks	2	3	1	2
Agricultural	-	8	-	3

[a] Sample size for a respective unit.

[b] Percent of observations for a respective unit.

Table 15. Seasonal distribution of mule deer among four classes of gradient during the report period.

Gradient	Fall 1977 (291)[a]	Winter 1977-78 (721)	Spring 1978 (189)	Summer 1978 (123)
0-15°	70[b]	46	61	62
16-30°	18	18	4	11
31-45°	11	22	15	15
45° +	1	15	20	11

[a] Sample size for a respective season.

[b] Percent of seasonal observations.

Table 16. Seasonal distribution of mule deer among ridgetops, drainage bottoms and four classes of exposure during the report period.

Exposure	Fall 1977 (291)[a]	Winter 1977-78 (721)	Spring 1978 (189)	Summer 1978 (123)
Level Ridgetop	6[b]	18	1	9
Level Bottom	50	15	39	22
North	11	16	22	15
East	8	4	17	19
South	14	30	17	16
West	11	17	4	19

[a] Sample size for a respective season.

[b] Percent of seasonal observations.

Spring: The ponderosa pine/grassland and grassland habitat types still accounted for nearly half of the observations of mule deer during spring 1978 but use of these types was down from the previous winter (Table 13). Other types receiving substantial use during spring included grassland parks, hardwood draws, sagebrush-rabbitbrush breaks and snowberry draws. Mule deer increased their use of drainage bottoms during spring (Table 16) perhaps in response to greenup of herbaceous forage in such areas.

Summer: The ponderosa pine/grassland and grassland habitat types continued to receive nearly half of the observed use during summer 1978. Hardwood draws and grassland parks also received substantial use during summer (Table 13). However, use of drainage bottoms by mule deer declined from spring (Table 16).

Food Habits

Food habits of mule deer were evaluated from rumen samples from hunter-killed deer during fall 1977. During winter, the relative use among various forage plants was determined from examination of feeding sites as described by Wallmo et al. (1973), Wilkins (1957) and others. Six rumen samples were obtained from deer taken on a collecting permit during summer 1978 but the results are not yet available. Data obtained during fall 1977 and winter 1978 appear in Table 17.

Fall

Among five rumen samples obtained during late fall 1977, browse, forbs, and grasses averaged 86, 3, and 10 percent by volume, respectively. Snowberry was the most abundant item in the late fall diet and occurred in four samples (Table 17). Oregon grape also occurred in four samples but constituted only nine percent of the diet. Other browse occurring in the late fall diet in appreciable quantities included plains cottonwood and green rabbitbrush (*Chrysothamnus viscidiflorus*). Among grass, bluegrasses accounted for most of that which was identified (Table 17).

Winter

Six feeding sites were examined, which included 1,317 instances of use, during January and February 1978. All were obtained in the Speelman, Plum, and Slick Creek drainages. Browse, forbs, and grasses averaged 80, 18, and 1 percent of the diet among the six sites respectively. Major browse items during winter included silver sagebrush (*Artemisia cana*), horizontal juniper, and big sagebrush (*A. tridentata*). Ponderosa pine and skunkbush sumac (*Rhus trilobata*) received only minor use on the sites examined (Table 17). Soapweed (*Yucca glauca*) was the only forb receiving substantial use by mule deer and its use was observed on three of the six sites.

Table 17. Food habits of mule deer during late fall 1977 and winter 1978 as determined from analysis of rumen contents and feeding sites, respectively.

Taxa	Late Fall 5 Rumens	Winter 6 Sites
BROWSE:		
Artemisia cana	40/ 3[a]	50/21
Artemisia tridentata	-	33/19
Berberis repens	80/ 9	-
Chrysothamnus viscidiflorus	20/12	-
Cretaegus succulenta	20/ 4	-
Juniperus communis	20/tr[b]	-
Juniperus horizontalis	-	33/21
Pinus ponderosa	20/ 1	50/ 9
Populus deltoides	40/16	-
Prunus virginiana	20/ 2	-
Rhus trilobata	-	67/ 7
Rosa arkansana	-	17/tr
Shepherdia argentea	-	17/tr
Symphoricarpos spp.	80/39	33/ 3
TOTAL BROWSE	100/86	100/80
FORBS:		
Artemisia dracunculus	-	17/ 2
Artemisia frigida	20/tr	17/tr
Phlox hoodii	20/tr	-
Yucca glauca	-	50/16
Unidentified Forbs	40/ 3	-
TOTAL FORBS	60/ 3	50/18
GRASSES:		
Agropyron spp.	20/ 1	-
Poa spp.	60/ 5	-
Unidentified Grasses	40/ 4	33/ 1
TOTAL GRASS	100/10	33/ 1

[a] Frequency (percent occurrence among samples or sites)/percent of diet.

[b] tr - trace (a value less than .5 percent).

Population Characteristics

When practicable, mule deer were classified as to age, sex, and group composition in the same manner as for white-tailed deer. As mentioned previously more than two-thirds of the sample was obtained from aerial surveys.

Group Behavior

During the report period 1,329 deer were observed in 305 groups. The distribution of groups of mule deer among 10 categories based on group composition appears in Table 18. Average group sizes by season, regardless of composition, were 4.0, 5.7, 5.2, and 1.8 during fall, winter, spring and summer, respectively.

During fall 1977, the type of group most commonly observed consisted of groups of adult females accompanied by fawns (Table 18) followed by single adult females with fawns and groups containing both adult males and females whether or not accompanied by fawns. During winter adult female and mixed groups were most prevalent. During summer solitary adult females were observed more often than any other type of group, followed by mixed groups characterized by the absence of neonatal fawns, and single adult females accompanied by fawns. Solitary adult males were more common during summer than during other seasons (Table 18). As determined from comparative seasonal average group sizes and group composition, mule deer in the study area were somewhat more gregarious than were white-tailed deer with the exception of the summer period when smallest average group sizes were observed among both species. Such a phenomenon may have been influenced by differences in site selection between the two species.

Population Numbers

An attempt was made to determine the size of the mule deer population in the study area during mid-December 1977 through early January 1978 from an intensive aerial survey. Flights were made on east-west or north-south coordinates at approximately .5 mile intervals during periods of optimum light and snow conditions. A total of 458 mule deer was observed of which 96 percent were classified as to sex (1½+ years) and age (fawn, yearling male, and adult). Subunits 1, 2 and 3 (Figure 6) accounted for 35, 32, and 33 percent of the observations, respectively.

A fawn:doe ratio of 53:100 resulting from this early winter survey compared closely with that observed during the previous fall (Table 19). However, the buck:doe ratio of 14:100 was considerably lower than that observed during fall 1977 (34:100). This influenced the fawn:adult ratio between the respective periods (42:100 to 47:100). It was unlikely that hunting mortality among antlered males was a major factor influencing relative abundance of adult males and females from fall to winter. An

Table 22. Upland game bird brood production in the Long Pines Study area during 1977 and 1978.

Species	No. Broods	No. Young	No. Hens	Average Brood Size	No. Young: Adult Hen
Merriam's Turkey	5*				
1977	5*	77	12	15.4*	6.4
1978	8	85	16	10.6	5.3
Sharp-tailed grouse					
1977	4	33	4	8.2	8.2
1978	2	13	2	6.5	6.5

* In the case of Merriam's turkey, individual broods may combine when young are 7-10 days old, thus forming brood flocks (Jonas 1966).

Miscellaneous Observations

A mountain lion (*Felis concolor*) was sighted on the national forest near Halbert Gulch on October 9, 1977. The presence of this species in Carter County was believed to be limited to an occasional transient (Lampe et al. 1974). Two reported sightings of these cats over the past year by deer hunters and U.S. Forest Service personnel suggested that they may occur more prevalently in some of the more remote areas of the county than previously thought. Mountain lions are protected throughout Montana with no open season in Region 7.

Bobcats (*Lynx rufus*) were also sighted on the study area during the report period. Two sightings were made on the national forest during summer 1978. The Montana legislature during 1977 took the bobcat off the list of predators and added it to the list of furbearers. Hunting regulations provide for seasons commencing December 1 and taking two bobcats per person per license year. Specimen and sight records for bobcats were not obtained in Carter County by Lampe et al. (1974). One sighting of two mink (*Mustela vison*) was made in the Speelman drainage during summer 1978.

Nongame Wildlife

Two graduate studies dealing with nongame birds in the Long Pines were initiated during summer 1977 (Dusek 1977). Both students continued and completed their field work during spring and summer 1978. One study dealt exclusively with birds of prey with special reference to the impact of human activity. The second study dealt with breeding bird distribution and density in various habitat types with most of the emphasis on passerine birds. Progress to date on both studies appears in the Appendix of this report.

Thirty-two of 50 species of mammals reported as occurring in Carter County were found to occupy the Long Pines (Lampe et al. 1974) and were listed in a previous report (Dusek 1977). Several of these species were observed in the study area during the report period. White-tailed jackrabbits (*Lepus townsendii*) and cottontails (*Sylvilagus* spp.) appeared abundant in the area. Among rodents, the least chipmunk (*Eutamias minimus*), red squirrel (*Tamiasciurus hudsonicus*), deer mice (*Peromyscus maniculatus*), bushy-tailed woodrat (*Neotoma cinerea*) and porcupine (*Erethizon dorsatum*) were observed during the report period as were coyotes (*Canis latrans*), red fox (*Vulpes vulpes*), raccoons (*Procyon lotor*) and striped skunk (*Mephitis mephitis*) among carnivores observed.

Evaluation of Recreational Use

Hunting was the most intensive form of recreation that occurred in the national forest portion of the study area. Campers and picnickers used the Long Pines during summer, particularly on holidays and weekends.

Snowmobilers used the area during winter. A spring turkey gobbler season offered recreational opportunities during the second half of April 1978. Only recreational use during the 1977 fall hunting season was monitored.

Traffic counters were installed at three entrances to the national forest during mid-September 1977 prior to the opening of the fall turkey season: Snow Creek, Speelman Creek, and the southeast entrance below Capital Rock. Traffic was also monitored at these locations during fall 1976 (Dusek 1977). Readings were taken just prior to and following each weekend from September 23 through November 18. Inaccessibility of the area due to a severe storm the last weekend of the deer season precluded obtaining readings on November 20, the final day of the 1977 deer hunting season. Traffic data served as an index of vehicular use between weeks, weekends and years (Figure 8).

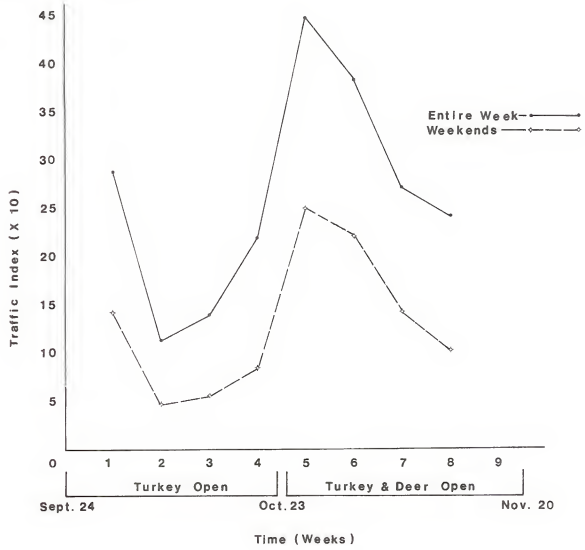


Figure 8. Trends in weekly and weekend use of the portion of the study area consisting of national forest during the fall hunting season of 1977 as determined from the use of traffic counters at three locations.

While traffic data at all three locations reflected the same trend throughout the fall hunting season during 1977, the Snow Creek entrance received the heaviest use among the three exits, accounting for 38 percent of the recorded use. This compared to 26 percent during 1976 when that entrance received the lightest use among the three entrances.

Forty-nine percent of the weekly traffic in the Long Pines throughout the fall hunting season during 1977 occurred on weekends which compared to 56 percent during 1976. The national forest received its greatest use during the first two weeks of the deer season (Figure 8) which began on October 23, a trend comparable to that observed during 1976 (Dusek 1977). The area received its lightest use of the period during the second week of the turkey season which was perhaps largely influenced by cold, wet weather. Hunter use of the area tapered off sharply following the second week of the deer season, but remained at a higher level than that observed during the three-week period prior to the opening of the deer season (Figure 8).

Questionnaires were distributed among 60 parties hunting in the Long Pines from September 24 through November 20, 1977. The questionnaire was used to determine the proportion of resident and nonresident hunters using the Long Pines, effort devoted to hunting turkey and deer, and hunter success.

Twenty-one of the 60 questionnaires were returned representing a response of 35 percent. Hunters per party averaged 3.2, or a total of 67 hunters among responding parties. Assuming this average held true for all parties contacted, a total of 192 hunters was contacted in the field during the 1977 fall hunting season. Resident hunters accounted for 57 percent of responding parties. Seventy-eight percent of the nonresidents responding hunted during the first two weeks of the deer season, while many resident parties hunted the Long Pines throughout the fall. However, 67 percent of the total hunting pressure occurred during the first two weeks of the deer season, agreeing closely with traffic data (Figure 8).

Among responding parties, success ratios for turkey and deer hunters during 1977 were 13 and 77 percent, respectively. The respective ratios for 1976 were 18 and 45 percent. Percent success among turkey hunters during 1977 may have been underestimated since the response rate among hunters contacted during the first week of the turkey season was disproportionately low. Most of the turkeys known to have been killed were taken during that week. The higher success ratio among deer hunters was attributed to a comparatively high white-tailed deer population characterized by substantial recruitment of yearlings into the adult population coupled with good annual production.

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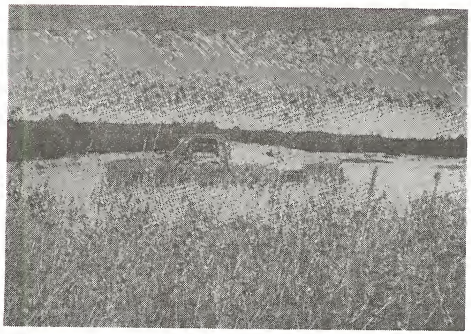
APPENDIX



AN ASSESSMENT OF POTENTIAL CONFLICTS BETWEEN BIRDS OF PREY AND HUMAN ACTIVITIES IN THE LONG PINES

Progress Report

August 1978

George T. Allen

This project is an assessment of the potential effects of human activities on birds of prey nesting in the vicinity of the Long Pines. Potential problems associated with uranium exploration and/or development are of primary interest, but other activities are also being considered.

Mobil Oil Corporation (Mobil) has carried out the only extensive search for uranium in the vicinity of the Long Pines, but Mobil has now terminated its exploration. Whether another firm will continue the exploration or will begin development is not known at this time.

The boundary for this study was altered this year, and the study area size was increased. This was done to include potential nesting habitat for the two species of primary interest and to include areas near roads which were traveled frequently. The final study area is shown in Figure 1.

Field work was conducted from 4 April through 28 July, but early season surveys were considerably hampered by extremely wet and cold weather during April and May.

This survey was conducted in part in conjunction with the raptor nesting study carried out by U.S.F.S. personnel on and around National Forest lands. Information was also added by Department of Fish and Game employees.

The information in the following summary of methods and results is preliminary; the final analysis will appear in my thesis.

Methods

Study methods were chosen primarily to locate nests of two cliff-nesting species; prairie falcon (*Falco mexicanus*) and golden eagles (*Aquila chrysaetos*). Potential nesting habitat and aerie or nest sites identified last year were surveyed early in the season to determine if they were occupied this year. Approximately two weeks after the initiation of incubation clutch counts were made at seven of the active prairie falcon aeries. Caution was exercised in all cases to avoid harm to eggs or nest abandonment due to visits by observers, and precautions for nesting studies identified by other researchers (Hamerstrom, 1970; Fyfe and Olendorff, 1976) were followed when possible. No nest failures or losses of eggs or young due to this study were noted.

As the nesting season progressed and the inventory of prairie falcons and golden eagles was completed, more time was spent in search of nests of other species. The loss of field time during the cold and wet weather of early spring however, meant that the inventory for other species was less complete.

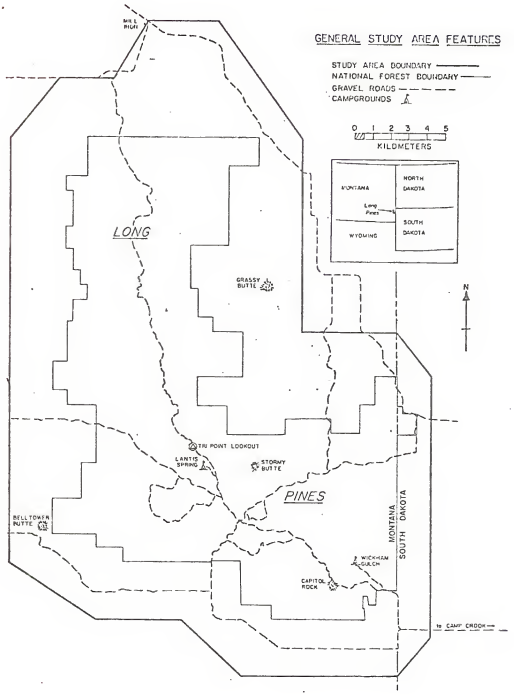


FIGURE 1. Outline of Study Area, with main roads and features.

The inventory of diurnal woodland nesting species such as accipiters was incomplete because there was not enough time or personnel for a survey of these species in the Long Pines area. The nocturnally active great horned owl (*Bubo virginianus*) was also only occasionally seen during the study period.

Sightings and initial nests locations were plotted on U.S.F.S. maps of the Long Pines area. For greater accuracy, locations of nests were later plotted on U.S.G.S. advance topographic maps of the study area.

Records were kept of clutch size, brood size, and number of young fledged for all nests where these could be ascertained. For prairie falcons and golden eagles records were also kept of cliff exposure or slope exposure for golden eagles tree nests, heights of nests above ground, and the height of the cliff or tree in which a nest was located. In most cases the measurements were made by lowering a rope marked at one meter intervals from the tops of the cliffs and having an observer indicate when the rope passed the nest and when it touched the ground below the cliff. For tree nests and a few cliff nests however, only estimates of heights were made.

No prey information was recorded because few visits were made to aeries and nests, and the sample of prey items would have been small.

At most prairie falcon and golden eagle nest sites, and at some nests of other species, the young were banded with U.S.F. &W.S. bands by the U.S.F.S. personnel. Standard rappelling techniques were used to make observations or to band the young at all cliff nest sites.

Results

Fifteen raptor species have been noted in or near the study area during the nesting season. Nine of these species are now known to nest in the study area, and a tenth probably nests there.

The results of field observations of these fifteen species in 1978 are as follows:

Cooper's hawk (*Accipiter cooperii*)- One nest of this species was found in the study area this year and a number of observations of Cooper's hawks in several locations within the study area indicate that several nests may have been located in the Long Pines. The nesting season for this species in the Long Pines runs from mid-April until late July.

Sharp-shinned hawk (*Accipiter striatus*)- Although this was occasionally sighted throughout the study area, no nests were found. They may nest within the study area, but an extensive effort would be necessary to locate nests. The nesting season for this species concurs with that of the Cooper's hawk.

Harrier (*Circus cyaneus*)- One Harrier nest was located within the study area this year, while behavior of other adults indicated nesting activity. The incubation and nestling period for this species in the study area, as indicated by this nest and several others on the Forest lands, runs from mid-May through July. Observations this year suggested that paired adults establish territories in early April.

Nests of this species found either in the Long Pines study area or in the Forest Service study areas were all located in dense snowberry (*Symphoricarpos* sp.) patches in savannah areas. It appears that such areas are highly preferred for nesting by this species in and around the Long Pines.

Red-tailed hawk (*Buteo jamaicensis*)- Three nests of this buteo were located during the study this year. Nests appeared to be scattered throughout the study area, but insufficient time was available for locating more nest sites. The red-tailed hawk is the only common buteo within the study area in the summer, and the population appears to be in good health. The incubation and nestling period for redtails in the study area begins in late April and runs to about mid-July. The nesting season begins by early April.

Golden eagle (*Aquila chrysaetos*) - Four active golden eagle nests were found in the study area this year. These nests fledged five young. Twenty golden eagle nest sites have been identified in the study area, seventeen of which are located on cliffs. For these nests the information recorded on slope or cliff exposure, nest height, and tree or cliff height is presented in Table 1. This information should help to determine where other nests might be located. The incubation and nestling period for this species in the Long Pines area runs from early March through mid-July. Nesting birds are present in the area in late February and early March.

Table 1. Physical data for golden eagle nests in the study area.

Location	Exposure	(meters) Cliff or Tree Height	(meters) Nest Height
Cliff	Northeast	8	3
Tree[a]	Northeast	16[b]	14[b]
Tree	East	14[b]	10[b]
Cliff	Southeast	8	6
Cliff	South	19	12
Cliff	South	14	10
Cliff	South	16	12
Cliff	South	21	15.5
Tree	Southwest	11[b]	9[b]
Cliff	Southwest	10[b]	5[b]
Cliff	Southwest	15	8
Cliff	Southwest	20[b]	17[b]
Cliff	West	12	8
Cliff	West	15	11
Cliff	West	9[b]	6[b]
Cliff	West	20[b]	18[b]
Cliff	West	14	7
Cliff	Northwest	10[b]	6[b]
Cliff	Northwest	10	8
CLiff	Northwest	13.5	11

[a] All tree nests were located in ponderosa pine (*Pinus ponderosa*)

[b] Estimated

Prairie falcon (*Falco mexicanus*) - Thirteen pairs of prairie falcons and twelve active aeries were located during 1978. Fourteen prairie falcon aeries have been identified in the study area. Five of the six aeries found in 1977 were active again in 1978. Physical data for prairie falcon aeries in the study area is presented in Table 2.

Table 2. Physical data for prairie falcon aeries in the study area.

Cliff Exposure	(meters) Aerie Height	(meters) Cliff Height
East	31	24
Southeast	11	9.5
South	11	6
South	9	5.5
South	22	13
Southwest	20[a]	13[a]
Southwest	10	5
Southwest	11	6
West-Southwest	9	6
West	10	8.5
West	30	26
West	17	13
West	20	11
West	8	5

[a] Estimated

In 1977 at least twelve young fledged from the three successful aeries in which young were counted. This year twenty-nine young fledged from the seven known successful aeries in the study area. Calculated productivity figures are 2.42 young fledged per nesting attempt, and 4.14 fledger per successful nest. Productivity for the active aeries this year is shown in Table 3.

The nesting season for prairie falcons in the study area can be considered to run from early April until mid-July. Nests of this species however, run as much as one month out of phase.

At one aerie site which was successful last year a pair of adult prairie falcons was present early in the season, but a great horned owl was occupying last year's nest site. The female prairie falcon disappeared before the next visit to the site, and no nesting took place.

Merlin (*Falco columbarius*) - Three nests and several approximate nest locations were found for merlins in the study area in 1978. Nests of this species are apparently scattered throughout the study area, but the nesting density for merlins does not appear to be high. The incubation and nestling period for merlins runs from late April through mid-July. In contrast to the observations of others (Brown and Amadon, 1968; Trimble, 1975; Craig and Renn, 1977), the nestling period for two nests in the study area this year was no more than twenty-one days.

Table 3. Productivity data for prairie falcon aeries in the study area in 1978.

Clutch Size	Brood Size	Hatching Success (%)	Number of Young Fledged	Fledging Success (%) Clutch/Brood
?	≥2	?	0[a]	0/0
5	4	80	4	80/100
?	4(?)	?	0[a]	0/0
5	≥4	≥80	0[b]	0/0
5(?)	5	100(?)	5	100(?)/100(?)
5(?)	5	100(?)	5	100(?)/100(?)
5	4	80	4	80/100
?	≥3	?	3	?/?
4	?	?	0[a]	0/0
5	≥3	≥60	≥3	≥60/≥60
5	≥4	≥80	0[b]	0/0
5	5	100	5	100/100

[a] Young disappeared [b] Young died

Kestrel (*Falco sparverius*) - Five nest locations and five approximate nest locations were recorded for kestrels in the study area in 1978. Four of the identified nests were in dead snags or cavities in live trees; the other was a pothole in a cliff. Nests of this species probably occur throughout the study area. The nesting season for kestrels is the latest of the falcons in the study area, and runs from mid-May through mid-July. A nestling period less than that recorded by other observers (Roest 1957; Smith et al. 1972) was indicated in one instance, but further study is needed to determine the normal nestling period for kestrels in the Long Pines.

Great horned owl (*Bubo virginianus*)- Scattered observations of great horned owls were made throughout the study area in 1978. Since immature birds were sighted, this species probably nests throughout the study area. Although no nests were found, holes in cliffs appeared to be likely nest choices. Locating nests of this species in the Long Pines was complicated by weather and travel conditions during early spring.

Turkey vulture (*Cathartes aura*) - Many observations of individuals and groups of turkey vultures were recorded in the study area in 1978. No nests were found, but this species was found to nest in the nearby Ekalaka hills, and it is likely that turkey vultures also nest in the Long Pines area. The nesting season for turkey vultures runs from early May through August in the vicinity of the study area.

Swainson's hawk (*Buteo swainsoni*) - Four observations of Swainson's hawks were recorded in the study area this year. This species may breed in the areas surrounding the Long Pines, but it is doubtful that it breeds within the study area.

Ferruginous hawk (*Buteo regalis*) - One ferruginous hawk was seen by observers within the study area in each of the past two years. This species nests in areas near the Long Pines but is apparently only an occasional visitor to the study area.

Short-eared owl (*Asio flammeus*) - One observation of an adult short-eared owl was recorded in the study area in 1978. This species also nests in areas near the Long Pines. Its status in the study area is uncertain.

Long-eared owl (*Asio otus*) - One adult long-eared owl was seen to the west of the study area in 1978. This species has been recorded as nesting to the west of the study area (Skaar 1975-1978).

Burrowing owl (*Speotyta cunicularis*) - One burrowing owl was recorded on the west edge of the study area in 1978. It is very unlikely they nest in the study area.

Uranium Activities

Mobil Oil Corporation has terminated uranium exploration activities within the study area and is apparently withdrawing from uranium development activities there. It is unknown at present whether another firm will continue or expand Mobil's efforts.

Should another firm do so, however, Mobil's claims and past drilling sites have been recorded, through Mobil's help, and are shown in Figure 2. These sites may indicate the location of any future activity.

In-situ mining appears to be the only feasible method of mining within the study area. All units of the Custer National Forest were withdrawn from surface mining under the provisions of the Surface Mining Control and Reclamation and Reclamation Act of 1977 (P.L. 95-87). In view of this, an effort has been made to analyze the potential effects of in-situ uranium mining on the raptors of the Long Pines. This analysis is the goal of my thesis, but also included will be an estimate of the potential effects of other activities, and management recommendations.

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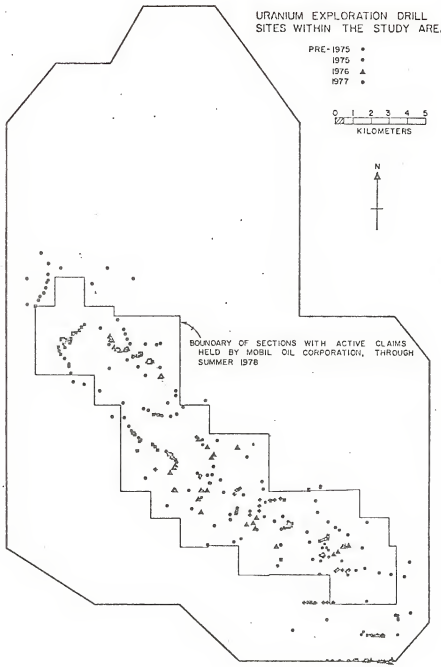

FIGURE 2. Mobil Oil Corporation's uranium exploration drilling sites, through the end of 1977.

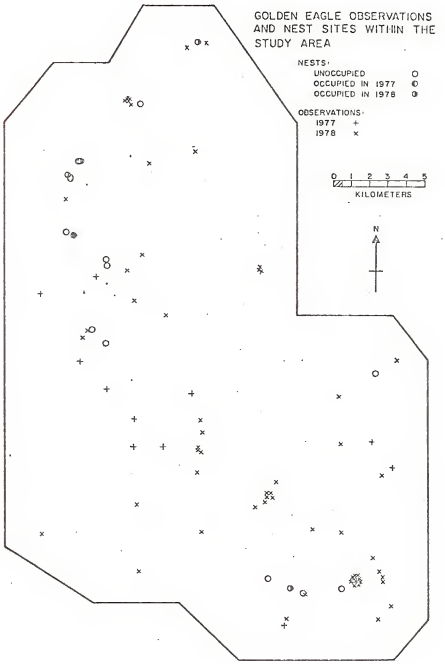

FIGURE X. Golden Eagle(Aquila chrysaetos) nests and observations within the Study Area, 1977 and 1978.

BREEDING BIRDS OF THE LONG PINES

Progress Report

September 1978

Kristi DuBois

A study to determine breeding bird densities was initiated in June 1977 and completed in September 1978 in the Long Pines in Southeastern Montana. The purpose of the study was to gather baseline data in light of possible uranium development.

Field work for 1978 was started in early April and completed in early September. The breeding songbirds on three 16 hectare plots and two 2 kilometer transects were mapped using the methods described by DuBois (1977). The data will be used to calculate breeding bird densities in each of four major vegetation types (mixed grass prairie, ponderosa pine savannah, ponderosa pine forest, and hardwood draw).

A transect route with 22 stops was used to determine species composition by habitat type as described by DuBois (1977). Two new stops were added in 1978 to sample rock outcrops and fields being invaded by ponderosa pine.

Birds of prey and upland game birds were recorded by location when observed throughout the study area. A species list of all birds observed in the study area was compiled. This list includes some winter residents and spring transients as well as breeding birds. Forty-three new species were added to the list in 1978, bringing the total study area list to one hundred and twelve.

During September 1977 the three plots and two transects were photographed with color infrared film. During March 1978, 8 x 10 color prints were made to be used along with ground data for detailed vegetation maps. A plant species list was compiled and plant collection made to describe the vegetation qualitatively. Grasses, forbs, and small shrubs were sampled quantitatively using the method described by Daubenmire (1959). Percent cover of larger shrubs and sapling trees was estimated in a 25 m^2 area (circle with radius of 2.82 m) at random points in each plot. Tree dominance, density, and frequency were determined using the point quarter method (Cottam and Curtis 1956).

The physical structure of the vegetation was described by measuring the heights of grasses, forbs, shrubs, and trees on each plot. The height of the lowest tree branches with living foliage was also measured to give an indication of foliage distribution in the tree canopy. Tree canopy cover will be measured from the aerial photographs. Breeding bird densities and species composition will be compared with respect to both the taxonomic and physical structures of each of the major vegetation types.

Additions to the study area species list:

1. Gadwall
2. Pintail
3. Green-winged Teal
4. Blue-winged Teal
5. American Wigeon
6. Northern Shoveler
7. Ferruginous Hawk
8. Bald Eagle
9. American Coot
10. Upland Sandpiper
11. Spotted Sandpiper
12. Solitary Sandpiper
13. Greater Yellowlegs
14. Wilson's Phalarope
15. Black-billed Cuckoo
16. Burrowing Owl
17. Short-eared Owl
18. Red-headed Woodpecker
19. Western Kingbird
20. Western Wood Pewee
21. Rough-winged Swallow
22. Barn Swallow
23. Common Raven
24. Pinyon Jay
25. Clark's Nutcracker
26. Brown Creeper
27. Gray Catbird
28. Brown Thrasher
29. Veery
30. Townsend's Solitaire
31. Loggerhead Shrike
32. Starling
33. Tennessee Warbler
34. Orange-crowned Warbler
35. Northern Parula
36. Yellow Warbler
37. Blackpoll Warbler
38. English Sparrow
39. Northern Oriole
40. Common Grackle
41. Pine Siskin
42. Savannah Sparrow
43. Vesper Sparrow (omitted from 1977 list by mistake)
44. Song Sparrow

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